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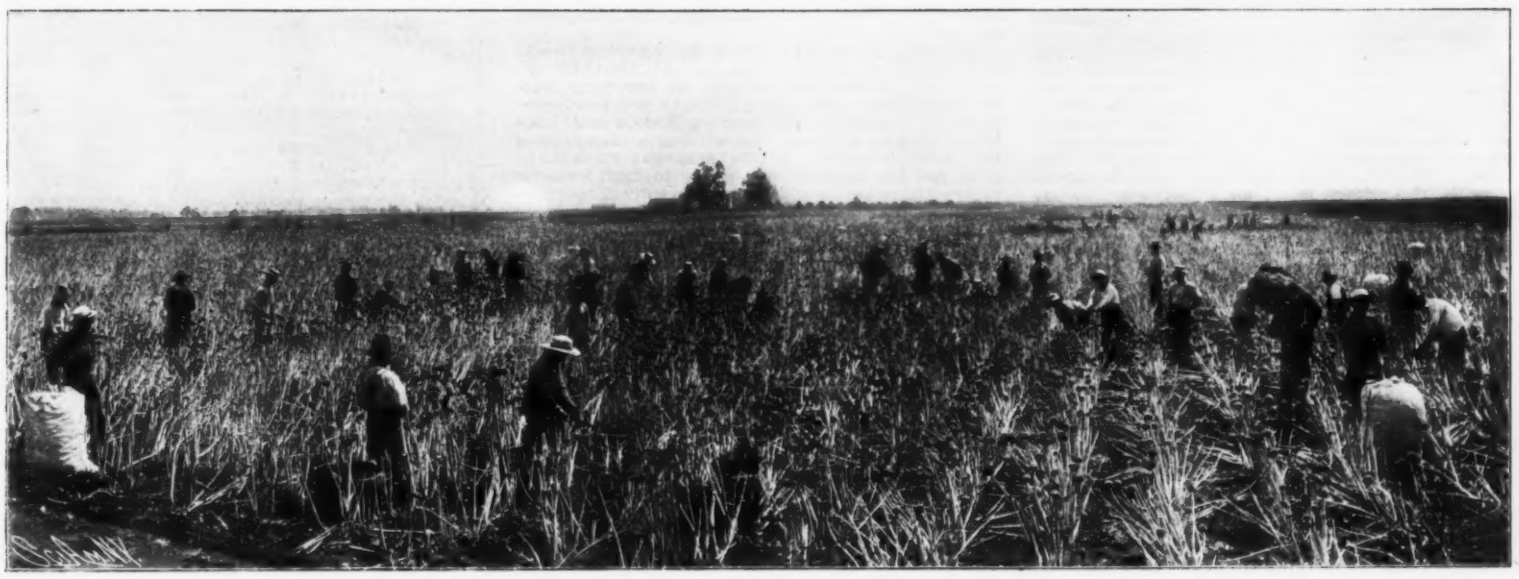
TRIAL GROUNDS

ONE HUNDRED ACRES OF SWEET PEAS.



SECOND GATHERING IN A 640-ACRE ONION FIELD.

GATHERING LETTUCE SEED.

LETTUCE IN THE HEAD.

A GREAT CALIFORNIA SEED FARM.

A GREAT CALIFORNIA SEED FARM.*

THE largest seed farm in the Western Hemisphere and the largest in the world, with the possible exception of one in Germany, is located near Gilroy, Cal., where over twenty-five hundred acres are devoted to this department of agriculture alone. The product is largely marketed in the United States, but a steadily increasing demand is found in Australia, South Africa, Japan, and China, as well as from the countries of Europe. Twenty-five years ago the East supplied itself, but the superior advantages of California for seed culture have caused almost a complete transfer of the industry to the far West. The seasons in California, which embrace regular periods of moisture and sunshine with the absence of severe frosts at all times, allow earlier planting and uninterrupted growth, besides insuring an absolute certainty of suitable weather for the harvest. Accidents common to the more variable climate of the East are absolutely unknown in California. The long season of sunshine with the invariably cool nights of summer, allow the fullest development even with the moderate rainfall of the winter months.

The cultivation of seeds involves the closest attention to detail and scientific accuracy at every step. There is not a rod of land in all the great tract which is not under daily supervision. A complete ground map of each subdivision, no matter how small it may be, is kept and the condition, growth, and nature of the crop on each is recorded. The probable yield of every section is calculated and thus, weeks before the harvest, the product of the whole farm is accurately known.

On this great farm, 325 acres are planted to sweet peas, 800 acres to onions, 200 acres to carrots, 250 to lettuce, 250 to radishes, 50 tomatoes, beets 50, celery 50, and equal acreage to cucumbers, parsley, leeks, parsnips, and other vegetables, besides a hundred varieties of flowers and large tracts for trial and experimental grounds and the necessary workshops and buildings attached to the estate.

The soil is black adobe mixed with sandy loam, and is of great depth and luxuriantly fertile. For the many years of cultivation, no sign of exhaustion is shown, though no fertilizers have been applied. Rotation of crops is customary. Cultivation begins with the November rains. The land is plowed to a great depth, followed by repeated harrowing, when planting, which is mostly by hand, begins. The onion is planted in December, sweet peas in January. As soon as the green sprouts appear, cultivation between the rows commences. Thinning the plants is done by hand. An average of the season's cultivation is six times by the plow, and three by the hoe for each crop. The labor expended in eradicating the weeds that spring up so quickly in the fertile soil is tremendous, and the resulting expense very great.

Of the acreage devoted to onions, 640 acres is in one field—a full square mile. Twenty-five varieties are regularly cultivated. Planted in December the seed matures in August and September, and thence gatherings are necessary. This is all hand work. Should a new variety develop, tests of the permanency of its character are made in the experimental and trial grounds and before it is introduced to the dealer, six years of close development and observation are required. First the seed of the novelty is planted, and successive growths under the eye of the expert will determine its permanent character. If the experiment is successful, the cultivation is transferred to the fields and confidently introduced to the market. It is the ambition of the seed raiser to originate a new variety whether of flower or vegetable. Financial gain and increase of prestige is the reward. Out of a billion plants growing in the fields, there is always a minute proportion which exhibit some divergence of color, shape, or form from the variety with which it is associated. Such a one is tagged, and its seed when matured carefully gathered and subsequently developed in the workshop of the farm by careful nurture and ceaseless oversight, and its development assisted by all the arts of the cultivator. Oftener than not, in spite of the most judicious encouragement, the result is fruitless, but the discovery of a new type in the process repays for a hundred disappointments.

In the attempts to produce new varieties, "hybridizing," or crossing of two types of the same varieties, is industriously practised. The process of fecundating one flower with the pollen from another is at least interesting, and is at times productive of extraordinary results; more often of complete failure.

Of the 1,025 varieties of the lettuce plant growing in the broad fields or in the experimental grounds, the same patient processes for the development of new varieties are followed. It is a remarkable fact that in different sections of the country certain varieties of this plant are demanded, which in other localities are rigidly proscribed. New York demands one variety and Philadelphia another. New Orleans will not accept what is most popular in Richmond. The West demands something different from what the eastern consumer most esteems. The seeds from the Santa Clara fields, therefore, embrace no less than 125 different varieties of this plant. The theory of original selection with subsequent experimental development applies to lettuce as well as to other vegetables.

The production of new flower varieties brings fame as well as fortune, and the resources and experiences of the growers are employed in developing varieties which are novel to the public.

The sweet pea continues to be without serious rivalry in public estimation and 1,025 varieties are either growing in the fields or are being subjected to final test in the experimental or trial grounds. The "Cupid," a bush or dwarf, was originated on this farm. One field of 100 acres in one variety may be seen in vigorous growth. The fragrance is overpowering. Vigilant watch is kept for stems bearing a new color or combination of colors. If found, the seeds, at maturity, are carefully segregated to be planted again in the trial grounds and there developed.

For a mile in width established varieties of flowers and vegetables are planted in parallel strips a quarter of a mile in length. A row of scarlet hued poppies stands next to a strip of white sweet peas, and in regular order the deep green of a strip of lettuce affords a pleasant contrast. Then succeed strips of different colored sweet peas, and so on until a gigantic banner, brilliant in many colors, is stretched along the ground like a floral mosaic. Everything about the Morse farm is conducted on a huge scale, and at harvest time 500 men are employed in gathering crops from a thousand different beds.

Seed gathering is an operation requiring sleepless vigilance and ceaseless attention. With the one exception of the sweet pea, the "tops" are gathered by hand. Even under the same conditions plants "seed" at different times, requiring from two to three gatherings before the beds are clear. The tops are first gathered into baskets and then emptied into bags and are hauled to the drying grounds where they are spread upon sheets and where they remain for two weeks, being turned by hand every day. By that time the seeds are thoroughly dried and are passed through a specially constructed separator and afterward through fanning mills. To clear seeds from the last vestige of chaff which remains they are dropped into a tank of water. The seeds sink to the bottom and the straw rises and is removed. A week's drying and another and final run through the fanning mills and the seed is sacked for shipment.

To determine the percentage of vitality in seeds, before they are finally shipped, an average is taken and planted in a glass testing house. If 85 per cent of the sample germinates the standard is attained. The value decreases in proportion to the percentage of seeds in the sample that prove unproductive.

The local grounds of the farm are for testing the purity of the stock and not for developing varieties, which is done in the "workhouse" as the experimental grounds are named. In the latter selections are tested to determine whether or not they are good breeding stocks. If not they are rejected. If promising the process of testing is continued for another season. The great object is to get seed strains pure.

The business of seed growing is one in which the element of confidence largely enters. A misrepresentation of the quality by the grower reacts disastrously in the loss of confidence in the buyer whose trade may be seriously affected by the distribution of a spurious article.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

PEPPER CULTIVATION IN INDIA.

THE pepper plant—*Piper nigrum*—which produces the white and black pepper of commerce, is a climbing vine-like shrub, found growing wild in the forests of Travancore and the Malabar coast of India.

It is extensively cultivated in southwest India, whence it has been introduced into Java, Sumatra, Borneo, the Malay Peninsula, Siam, the Philippines, and the West Indies.

The use of pepper was known to the ancient Greeks and Romans as early as the time of Alexander the Great, and at one time occupied an important place in the world's traffic, being a staple article of commerce in the early trade between Europe and India before the days of cotton, tea, and sugar. The price of this spice during the Middle Ages was exorbitantly high, and its excessive cost is said to have been one of the inducements which led the early Portuguese navigators to seek a sea route to India.

Pepper is entirely tropical in its requirements, and seems to thrive best in a moist, hot climate, with an annual rainfall of at least 100 inches and a soil rich in leaf mold.

The plant is a natural climber and will cling to almost any support by means of adventitious roots. It grows some 20 feet in height, but in cultivation is usually restricted to 10 or 12 feet. The native Kanarese, in the gardens of the southern district of the Bombay presidency, train the pepper vine to the "supari" palms.

The leaves are glossy, broadly ovate, with five to seven nerves, and grow opposite and alternate to a pendulous spike 5 to 8 inches long, containing 20 to 30 white flowers that ripen into a one-seeded fruit, with a fleshy exterior. This fleshy berry, covering a soft stone, is about the size of a pea, and is at first green, but in ripening turns red and then yellow.

The berry contains a resin, to which it owes its hot, pungent taste, and a volatile oil that gives off an aromatic scent. It has few medicinal qualities, its principal use being as a condiment.

The white pepper is the black pepper decorticated by maceration and rubbing. The plant produces fruit in three years, and is probably at its best for the next seven or eight years. It is claimed that there is a difference between the plant grown from the seed and the one raised from cuttings, the former bearing fruit for several years longer than the latter, though the pepper from the plant raised from cuttings is said to be superior in both quality and quantity, and hence this method is more frequently adopted.

A single palm or tree sometimes supports 8 or 12 vines, giving an average annual yield in good seasons of about 1,000 berry spikes to the vines on one palm. These spikes or clusters of berries vary in size, but 1,000 should yield on an average 5 pounds of dried pepper. An acre is reckoned to bear 2,500 plants, to cost about $20 in outlay, and to yield a product of $400 when in its best condition.

Mr. J. W. Mollison, director of agriculture at Poona, gives in a very interesting paper an account of the cultivation of pepper in the Kanara gardens of the Bombay presidency. Of the two ways of propagating the plant—by layering or from cuttings—he claims the former is preferable.

When the palms have been seven or eight years permanently planted, pepper is planted at the roots of the trees. If a long, healthy vine from an established plant can be stretched to reach the root of the palm, this vine is layered in the leaf-mold manure which surrounds the root of the palm. The pepper vine takes root freely in this manure, and when it has done so it is severed from the parent vine and trained on the palm stem.

The young pepper plant grows rapidly. The main vine should branch freely into subordinate vines so that a number can be trained up the palm. They are fully secured to the stem by bands stripped from the sheaths of the fallen leaves of the palm. The main and subordinate vines grow up the tree to a height of 5 feet or more per annum. Luxuriant growth and free branchings are encouraged by heavy applications of good manure given annually for three years after planting.

Subsequently, the pepper plant participates in the general cultivation given to the palms, and an application of manure is given for both crops every second year. The best manure for pepper, supari palm, and all other crops of the garden is made from green leaves plucked or pruned in the monsoon and used as litter in the byres where buffaloes and other cattle stand, and thence removed to a deep manure pit every day with the excrement of the cattle. This manure is sufficiently decayed by the following March, and is applied in that month or in April.

The foliage of healthy plants is, from the ground upward, fairly dense, but in an established plantation some of the older vines die. If new layers are substituted for old and worn-out vines, the plantation should keep in vigorous growth and bearing for a long period.

The flowers appear in July and August and the berries about seven months later. The yield depends upon liberality in manuring, upon proper management, and upon the rainfall.

The plant, the flowers, and the fruit are delicate, in the sense that they may be damaged by rough handling; therefore, ladders are used when the vines are bound to the palms and the berries plucked. The ladders are straight, single bamboos, with the alternate side branches cut off a foot from the stem. These provide the steps of the ladder. A wooden hook is rigidly attached at the top end of the ladder and secured to the palm above the level of the tallest pepper plants.

The bunches are plucked by hand and placed in an oblong cane basket, slung horizontally behind the workman by a rope around his waist. The rounded ends of the basket extend a little on either side, so that the basket can be easily filled by either hand of the workman.

When plucked, all the berries in the bunch may be fully ripe, but ordinarily the bunches are plucked when the berries are mostly green and just changing in color. The berries may or may not be sorted as they are plucked. If they are sorted, those fully ripe are separated. These are soaked in water for seven or eight days or heaped, so that the pulp ferments, and are then rubbed by hand or on a coarse cloth if the quantity is small, or trampled under foot if the quantity is large. The pulp is thus rubbed off the inner stone. This stone furnishes the white pepper of commerce. The pulp is completely removed by washing in baskets in running water. The pepper is then dried by exposure to the sun for about a week. This has also a bleaching effect, and the pepper becomes pale gray or pale drab in color. It can be bleached whiter by a chemical agency. This white pepper is prepared only to a limited extent in the Kanara forests.

The chief product is black pepper. It is got from unsorted berries, which are heaped up for four days. The green berries then get softer and change color, and the pulp of all is more or less squashed. The berries are then spread out and dried. The skin and part of the pulp adhere as a dark-colored, dry, wrinkled covering to the stones, and the pepper is black in appearance.

White pepper is less pungent and more expensive than black, but is preferred by many from its not being readily seen in the food. The pepper produced on the Malabar coast of India stands high in grade and brings the best price in commerce.

I have not at hand sufficient data to determine even approximately the quantity of pepper produced in southern India. It is certainly a very large and important product. The natives use it freely to season their rice and curry, and no doubt as much is consumed locally as is exported.

During the year ended March 31, 1902, there was exported from Bombay to Indian ports, such as Calcutta, Madras, Rangoon, Karachi, and to Kathiawar, Portuguese Goa, Kutch, Gaekwar State, and other British and native states in India, 3,163,826 pounds of pepper of a value of $343,805.

During the same period there was exported from Bombay to foreign countries 2,487,883 pounds of pepper, valued at $277,914.

The total of the coastwise and foreign exportation of pepper shows a production above the supply for local consumption of 5,651,709 pounds of a value of $621,719.

It may be of interest to state that of the exports, Egypt took 608,000 pounds; Aden (and Arabia), 767,000 pounds; Persia and Asiatic Turkey, 800,600 pounds—or of all the pepper exported from Bombay to foreign countries, about 90 per cent was consumed by the four countries named.

WM. THOS. FEE.

Bombay, India.

A BOTANICAL EXPLORATION OF CUBA.

ASSISTANT CURATOR F. S. EARLE, of the Botanical Museum, who has just returned from a botanizing expedition in eastern Cuba, thinks the ordinary Cuban laborer about the poorest specimen of his kind that he has ever encountered. He says that he displays an airy indifference to the exigencies of any situation which renders him more difficult to handle than the negro of the Southern States, the Chinaman of California, the "Greaser" of the Southwest, or any other workman upon whom Dr. Earle has had to depend during his various explorations in remote corners of the continent.

The party, which included Prof. Underwood, and also E. D. W. Holway, of Iowa, who went for the purpose of collecting rusts, went to Baracoa, on the north coast, at the extreme eastern end of the island, attracted by the moisture conditions, which render that an attractive spot for botanists. An American settler, Charles Cooper, who at that time was in Baracoa with his family, placed the house on his cocoanut plantation, back in the hills, at the service of the party, and their first trip was some seven miles into the mountains to this ranch. There was no road, and the mule trail at times took its meandering way along the bed of the rushing creek or skirted the rocky precipices along the bank. The poor little mules, which throughout Cuba are about the size of western burros, had

pretty hard work to climb the trail, loaded with the heavy bundles of "driers," paper for preserving the specimens. At one point the entire party stopped to rescue one of them from a ditch where he had rolled with his load of driers, landing neatly with heels up, nicely balanced on his pack. The day was consumed in making the trip of seven miles, including a rise in altitude of 1,800 feet.

They had an arrangement with the guide to return for them on a certain day, but at the appointed time he failed to appear. A messenger being sent to Baracoa for him, he sent a polite reply to the effect that he would not transport that luggage over that trail again for $1,000. Another outfit was obtained, and the party started on the return trip. Half way down the mountain a trunk on the back of one of the mules shifted and the mule kicked. The "mule whacker" and his assistant thereupon proceeded to remove the box from the animal's back. The scientists watched him with interest, supposing he was going to shift the luggage and make a place for the box elsewhere. But what was their astonishment to see him calmly set the trunk down beside the trail and prepare to continue the journey without it. The professors expostulated in the best mixed Spanish and United States at their command, and one of the Cooper boys, coming up, continued the job in good, healthy Cubanese. All to no avail. The mule driver herded up his gang and went light-heartedly on his way, leaving a trunk of valuable specimens by the roadside.

A return to the Cooper ranch, the securing of a Cooper mule, the slow and painful adjustment of the trunk upon its back, and a tardy arrival in Baracoa were among the things that helped to form Dr. Earle's opinion of the Cuban laborer. The guide not only demanded, but apparently expected full pay for the trip, and was grieved and astonished when the hard-hearted Americanos did not see it in that light.

On the evening before they were to sail a man appeared at the hotel and applied, as they supposed, for the job of putting their baggage on board the steamer when she came in next day. They spoke a little Spanish, one of the waiters at the hotel spoke a little English, and between them, as they thought, the bargain was satisfactorily made.

The steamer's whistle sounded at noon the next day, and no one had yet come for the baggage. They hunted up the waiter and ascertained, through the medium of his pulverized English, that the man was a boatman, and had only agreed to take their things from the dock to the steamer in his boat. All requests to find a teamster or expressman who would take their traps to the dock were met by shrugs, outspread hands, and other eloquent gestures of impossibility. It was a saint's day, and, worst of all, the saint was good San José. It seemed that half the male population of the region was named after San José and the rest were related to them. The town was given over to processions and rejoicing, and not a man in it would harness a horse that day.

Time grew short. There was not another steamer for a week, and the Americans grew desperate. It finally ended in the securing of two disreputable wheelbarrows and the piling of boxes of valuable specimens thereon; and then might have been seen the spectacle of two very warm American scientists trundling their baggage through the streets of Baracoa, amid the admiring inspection of an interested populace. One wheelbarrow broke down, and it was necessary to leave the things beside the road and make a second trip to get them; and when the perspiring botanists were finally on board the steamer, it was with a rooted conviction that the Cuban laborer is a gentleman who does not have to work.

Baracoa is a region of beautiful climate, scenery, and vegetation. The range is two or three miles back from the coast, and rises to a height of 3,000 feet. On the flanks are banana and cocoanut plantations, the product of which is all brought down for shipment on the backs of the ridiculous little mules, or in canoes on the little rivers. There are three American families in the region, but they lead a rather lonely life, especially the women, who have to do all their shopping by mail order in the United States. In the stores of Baracoa, a town of 3,000 inhabitants, the scientists could hardly find provisions for a camping expedition. There were no decent canned goods, and they visited four groceries before they found any cornmeal, while that finally discovered proved to be moldy and uneatable. The yam is the basis of the native menu, and dried codfish from Canada the staple meat, the people consuming more of this than of the fresh fish with which the waters abound. A great many live almost entirely on fruit, and their physique and general condition do not speak particularly well for that kind of a diet.

"The average man, white or black, is rather a poor specimen physically in Cuba," said Dr. Earle.

The country impressed him as one of great resources, almost totally undeveloped. Since the completion of the Cuban Central Railway a few months ago, fine mahogany and West Indian cedar, used for making cigar boxes, are being taken down to Santiago by rail. But in large sections all transportation is still by mule and small boat. It is necessary to cultivate the banana a little, but the cocoanut, once planted, requires no cultivation; oranges and limes grow half wild, and in general all fruit trees grow practically wild after being planted.

"The most striking feature of the vegetation is the royal palm," said Dr. Earle. "It is very abundant in all the lowlands, and grows up to an altitude of 2,000 feet. It reaches a height of 100 feet, and the trunk is frequently two feet in diameter. It has a hard rind, which is used for slabs to board up the sides of the plantation houses. Most of the Cuban shanties are thatched with the leaves, and there is a membranous stipule at the base of the leaves which they cut out in pieces two or three feet square and put over the sides of their houses like building paper. Such a house will not have a dollar's worth of purchased material in it. A handful of nails represents the sole monetary outlay.

"The tree ferns form another salient feature of the vegetation. They grow 30 or 40 feet high, with a straight trunk and tuft of fronds at the top. But they are so tangled in a mass of vines and creepers in the forests that it is difficult to see them to advantage. And, speaking in general, there is no such pageant of bloom at any time in the tropical forests as comes in our Northern woods in springtime. It is a continuous thing, scattered over the whole year. There is splendid collecting around Baracoa, where it is very moist. It is far drier at Santiago, and on the southern coast in the dry season it is extremely like New Mexico and Arizona, and the vegetation partakes of the same general characteristics.

"At the front of the mountain range that rises to the rear of Baracoa are jagged rock peaks, but in behind is an area of comparatively level land, covered with heavy forests. There are numerous deep, moist sinkholes, filled in with tree ferns and other moisture-loving growths, and yielding the collector a rich crop of ferns, mosses, and liverwort.

"Later we visited Alto Cedro, a construction camp on the Cuba Central Railway, where work is being actively pushed. It is in the heart of the great forest area that occupies the interior of Eastern Cuba, extending unbroken for sixty miles, and containing mahogany and West India cedar of great value. The forest is an almost impenetrable jungle of vines and bushes, and in the rainy season is almost a swamp. Owing to the difficulty of travel and transportation, the botanical exploration of Eastern Cuba is going to be anything but an easy job, but the results to be obtained will be more than enough to justify the effort. A rugged, mountainous region west of Baracoa is almost absolutely unknown. The high range near the west coast of Santiago is practically unknown, and promises rich returns."

Dr. Earle brought back 1,700 different specimens, about one-third of the collection being flowering plants, the rest including mosses, ferns, and fungi. He leaves in a few days for Porto Rico, in company with Dr. M. A. Howe, of the Botanical Museum. The latter goes to look for seaweeds, and Dr. Earle will collect fungi and examine plant diseases in the island.—N. Y. Times.

THE HABITABILITY OF MARS.

By LEIGH PAGE.

TELESCOPIC observation of Mars reveals three classes of markings, the permanency of which shows that they are due to surface conditions and not to clouds, such as we see on Jupiter or Saturn. The white polar caps already described, although they occupy only a comparatively small area, are specially conspicuous. Secondly, there are bluish green patches covering about three-eighths of the planet's surface, and lastly orange and yellow regions extending over the remainder. The latter have always been conceded to be land and the general opinion at present is that they are not only land, but deserts. They have exactly the color of deserts, and they behave just as arid countries should, that is, by not behaving at all—by remaining unchangeable.

For a long time the darker portions were supposed to be seas, and the early areographers have given them names conforming with this idea. Observations made at the last favorable opposition, however, satisfactorily disprove their aquatic character. Not only are they of every grade of tint, but even the same portions vary in color at different times. The polariscope shows no traces of the polarization which should characterize all light reflected from a smooth surface such as that of a liquid. Moreover, at times in the year the majority of these so-called seas gradually fade away and become indistinguishable from the yellow regions. The most conclusive evidence of all, however, is that the canals, to be shortly discussed, do not stop at the edge of these dark areas, but actually cross them.

Although the seas are not seas, they can be explained absolutely satisfactorily by ascribing their appearance to the growth of vegetation. In winter, the time that they turn yellow, the vegetation disappears; in summer, when water from the melting polar caps reaches them—for they are probably the lowest portions of the planet's surface—trees and plants spring up and their color becomes green again. The permanently yellow regions are never touched by water and so remain everlasting deserts. Of course, all this reasoning presumes that the polar caps are really composed of frozen water, which there is sufficient heat to melt.

Now comes the most interesting part of the study of Mars—the evidences of intelligent human beings—the canals. In 1877 the Italian astronomer Schiaparelli discovered these straight lines on the planet's disk. At first no one else would believe in their existence, for it was not until 1886 that any other astronomer succeeded in seeing them. Since that time they have been repeatedly observed and new details connected with them have been discovered.

We really do not see canals themselves, for they would have to be fifteen or twenty miles wide to be visible to us even with our best telescopes at such a distance. What we do see are probably belts of verdure bordering their shores. Their length varies from 250 miles to 3,540 miles, greater than the distance from New York to San Francisco. The belief that the canals are artificial is supported by the following facts: They are without exception arcs of great circles, joining different points in the shortest lines possible. Moreover, they make a *system*. Different canals do not cross each other hap-hazard, but several meet at one spot. There are extremely few places where only two canals cross; usually six or seven come together at the same spot. This suggests that they are fissures radiating from centers of explosion. But such cracks would gradually become narrower and narrower toward their extremities, while the canals maintain the same width throughout. Besides, cracks would reach an *end*, while the canals invariably go to some other intersection. The regularity of the canals seems to disprove all natural explanations. Rivers do not commonly have a bump for mathematics, and meteorites are not especially trained to plough straight furrows from one center to another. Canals they seem to be, and if they are canals the economic part of the question is very simple. The only water on Mars, if indeed there is any, is collected every winter in the polar caps by successive frosts, for rain never falls on any part of the surface. Now the question of all importance with the Martians would be irrigation. As telescopic observations of the terminator show no mountains of any size the Martians would be able to dig these tremendous ditches to convey the water from the polar seas to the arid interior. In the dark green portions of the planet's surface the canals probably overflow, thus producing vegetation all over them during the summer months, while in the yellow regions the only verdure is along the banks of the canals and in the oases which appear at every junction.

These oases are from 75 to 150 miles in diameter and are perhaps the sites of Martian cities. They are proved not to be lakes by the same means that the dark blue regions were proved not to be seas.

One mysterious phenomenon in connection with the canals is their gemination. Not all become double, and those that do, become so only at fixed seasons of the year. The fact that in the same telescopic view will be seen some double and some single canals seems to show that this phenomenon cannot be an optical illusion. Perhaps some explanation will be forthcoming as a result of observations to be taken at the next favorable opposition in 1907.

Even if Mars is really inhabited, only one-half of the problem of its life has been settled. Much more difficult than the question of his existence is the speculation as to what the Martian is like. However, we may derive one of his possible characteristics from the mere effect that the planet's mass would have on the size of its inhabitants. Contrary to what would be supposed at first thought, the Martian would be likely to be much larger even than Goliath. A little reasoning will make this clear. The larger a terrestrial animal the more unwieldy it is. An elephant refuses to jump like a squirrel not because he may consider it undignified, but simply because it is physically impossible for him to do so. If we could, we would leap over a high fence instead of laboriously climbing it. Our inability to perform such feats depends not so much upon our physical build as upon the force of gravity. Consider for instance the case of standing erect. The weight of the body, which is of three dimensions, opposes itself to this, whereas the cross-section of the muscles of the knees, which has only two dimensions, enables us to do it. Consequently the larger a man the sooner standing tires him. The same principle can be equally well illustrated by inanimate objects. Of two similar candles, one ten times as big as the other, the larger will settle under the great pressure due to its weight, while the smaller will stand indefinitely.

Now let us transfer our minds back to Mars. Imagine a Martian three times as large in every dimension as one of ourselves. On the earth he would weigh twenty-seven times as much, but since the superficial gravity of Mars is only about one-third that of the earth, he would weigh only nine times as much there. But the cross section of his muscles would be nine times as great. Therefore he would experience no more difficulty in standing or walking than we do. Yet since his muscles, having three dimensions, are twenty-seven times as large as ours, they would be twenty-seven times as effective. Furthermore, work on his planet, owing to the small gravity, would require only one-third the effort. Accordingly, he would be able to accomplish eighty-one times as much as a terrestrial man. In reality the surface gravity on Mars is slightly more than one-third that on the earth, so this ratio should be fifty rather than eighty-one. Thus if nature has taken advantage of this physical fact, is it at all remarkable that such beings might have constructed immense canals over a nearly level surface?

The reader must keep in mind that these deductions refer only to the possibility, not at all to the probability, of such giants living in Mars. These mathematical truths permit the existence of such beings there, but it may well be that the Martian, if such there is, is of the same size as man. Anyway the canals could be explained as well by attributing superior brains to the Martian as by endowing him with enormous muscle. At all events he must have brains at least equal to our own if the wonderfully regular works of irrigation are his.

Having speculated on the size of the Martian, let us next consider his shape. It is not at all probable that the highest forms of beings on Mars, where the environments are entirely different from our own, would have been evolved similarly to man. The latter is somewhat of an accident. His physical organism is not even the highest known to us. His brain is what has made him the dominant creature of the earth. On Mars brain may have developed to its highest stage in some totally different kind of animal. Man on Mars may even look more like a lizard than anything else, although of course his physical form would be largely determined by the uses he made of the several parts of his body. There is very little chance that he would resemble us in any physical features.

Now we have examined the arguments, pro and con, concerning the possibility of life on Mars, and have reviewed the evidences of its habitation. Many believe that the earth is the only place where life and human beings can exist. To be sure we have no more positive proof than that here roughly outlined to lead us to believe that there are other inhabited worlds, but on the other hand we have absolutely no negative evidence on this point. Even if Mars be dead, what reason is there for believing that none of the countless millions of suns, spread out in all directions in infinite space and showing all stages of development, have planetary systems at least one of whose members has reached a suitable condition and developed life, possibly of a far higher order than any known on earth? Such speculation, however, must be left for the minds of poets; where there are no means of obtaining data, here scientific investigation cannot proceed.—Yale Scientific Monthly.

Straw Presses in Russia.—The British consul-general at Odessa states that presses for pressing straw from the thrasher in the field for convenience in carting to the homestead where it is used for winter fuel can find a ready sale in that district. A machine was offered at $720, but did not work successfully. It is thought that a press which would meet all requirements would be sure to sell.

THE VALUE OF IMPORTED GEMS.

THE total value of precious stones imported into the United States in 1902 was $25,412,776, being $550,209 in excess of the value of gems imported in the previous year. The total production of precious stones in the United States in the same year was $318,300, as compared with $289,050 in 1901 and $333,170 in 1900. These figures and many interesting facts regarding the production and trade in precious stones are set forth in a report on that subject just prepared by the Geological Survey. The report contains, in addition to much that is of great economic value to the precious stones industry, many interesting and curious statements of a more general nature. The statement is made, for example, that the largest pile of diamonds ever brought together was collected at the De Beers Mine in South Africa, in July, 1900. The directors of the company were desirous of knowing the quantity of diamonds necessary to fill a measure of 76 cubic inches. Diamonds of all kinds were piled up just as they had been mined, and it was ascertained that a cubic meter of diamonds weighs 11,976,000 carats and has an approximate value of 378,250,000 francs, or $75,650,000.

The peculiar business methods of Oriental merchants are illustrated by the manner of buying rubies in Burma. In the examination of rubies artificial light is not used, the merchants holding that full sunlight alone can bring out the color and brilliancy of the gems. Sales must therefore take place between the hours of 9 and 3, and the sky must be clear. The purchaser, placed near a window, has before him a large copper plate. The sellers come to him one by one, and each empties upon this plate his little bag of rubies. The purchaser proceeds to arrange them for valuation in a number of small heaps. The first division is into three grades, according to size; each of these groups is again divided into three piles, according to color; and each of these piles, in turn, is again divided into three groups, according to size. There are thus twenty-seven grades in all, in addition to the larger stones that are set aside for valuation and sale singly. The bright copper plate has a curious use: The sunlight reflected from it through the stones brings out a color effect with true rubies different from that with red spinels and tourmalines, which are thus easily separated. The buyer and seller then go through a peculiar method of bargaining by signs, or rather grips, in perfect silence. After agreeing on the fairness of the classification, they join their right hands, covered with a handkerchief or the flap of a garment, and by grasps and pressures, mutually understood among all these dealers, they make, modify, and accept proposals of purchase and sale. The hands are then uncovered, and the prices are recorded.

The large single stones are valued according to color and shape for cutting, the very fine ones bringing high prices. A ruby of 36½ carats from the Mogok Mine some years ago brought 90,000 rupees ($30,000) at Calcutta.

THE MECHANICAL SORTING OF POSTAL PACKAGES.

WHEN we say postal packages, we mean all those small-mail-coach parcels that are daily sent in great numbers from the various offices and railway stations of Paris, because they respond to the most urgent requirements of commerce. The Austerlitz station of the Orleans Railway at Paris daily ships from 18,000 to 26,000 packages of this kind to the different parts of its system. Let us say at once (for we shall presently see that such distinction is important) that in order to facilitate the unloading, as well as to prevent loss and damage, these small parcels are packed either in hampers or sealed cars, the latter being destined for a large station, and the former for the various small stations of the same section. Some goods, of a fragile and cumbersome nature, as well as fruit, are transported uncovered. Two-thirds of this enormous mass of packages always arrive between six and eight o'clock at night, shortly before the starting hour of the trains that are to carry them, and so it has become necessary to have recourse to mechanical methods for effecting the sorting, or, more accurately, the shipping and classification of them, a small number of stationary employes assuming the sorting proper, according to the destination inscribed upon the parcels and cases. All the mechanical operations that we are about to describe are controlled electrically.

When the packages are delivered at the station by the customers, or when they are sent to special agents in the company's city offices, they are not only labeled, but always provided with a chalk mark which shows whether they are to be placed directly in a car or to go provisionally to a magazine in which they will be stowed after having been packed in a hamper. The employes must, therefore, know the trains and the magazines that correspond to them in any given direction; but this is an easy matter. The packages that are to travel uncovered are carried directly to the freight cars without being mechanically sorted. After being marked, all the packages are thrown by an employe into a hopper very close to him. There are nine such hoppers distributed along the platform of the cars bringing the parcels, so that the receiving and sorting employe has always within reach of him a hopper, the movable top of which has been lifted, in order to allow the packages to slide down an inclined plane to an endless belt. There are two of these belts, which move in opposite directions, and each of which does duty for a part of the hoppers and ends at one common point—the first sorting table. In fact, these belts terminate, or, more exactly, turn around (since they are continuous), upon reaching the edge of a table installed in a subterranean chamber, and in front of which stand the employes whose business it is to do the sorting. This subterranean chamber forms part of the magazines in which are deposited the packages to be placed in hampers, and which are four in number. The employes, guided solely by the number or mark carried by the package, pull it toward them after it has been dumped upon their table, and then place it upon one of the short belts that end at the latter in a direction at right angles with the two carriers of which we have just spoken. These belts themselves have a motion that tends to carry the packages far from the table. They are six in number, although doing duty for but four magazines, because two of them are designed to permit four employes to work simultaneously when need be. But two employes always suffice, even during a rush. Let us remark that when the sorters see a package marked with a 7 (the mark of the packages going to a full car) arrive in front of them, they place it upon a belt running above their head; and whither this carries it we shall presently see. But, for the moment, let us follow the packages that have been deposited upon the transverse belts. These are carried respectively to one or the other of the two superposed carriers which extend for the entire length of the subterranean chambers.

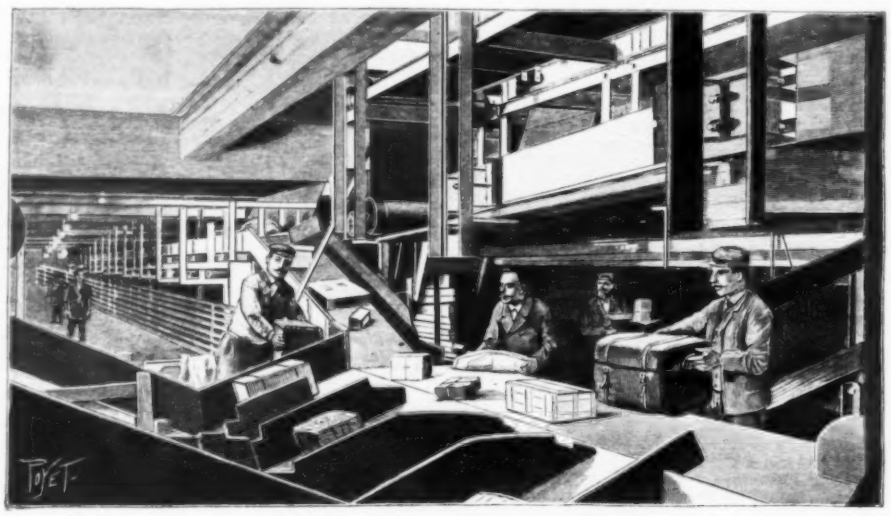


FIG. 2.—SORTERS AT THE FIRST TABLE.

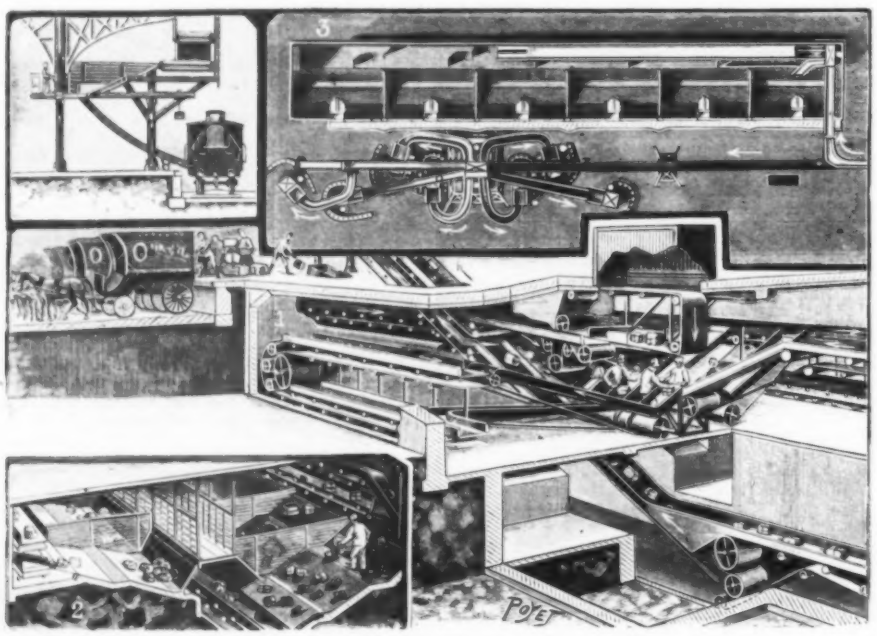


FIG. 1.—DETAILS OF THE INSTALLATION.

1. Diagram showing how the parcels are put in store. 2. Emptying of a magazine for the formation of a train. 3. Plan view of the first story. 4. Descent of the packages into a car.

Through ingenious arrangements, the packages deposited upon and carried along by the lower belt situated to the right, for example, of the row of magazines, are dumped into magazine No. 1 when they come opposite to it. This is brought about by a transverse strake which forms an angle with the belt and grazes the surface of it, while at the same time moving slowly back and forth from one end of the magazine to the other at a speed much slower than that of the belt. It will be seen that in this manner the packages are pushed throughout literally into the magazine, properly spaced apart, and distributed its entire length. The floor of the magazine is in the form of an inclined plane, intersected by two landings in the shape of passages. In the upper one of the latter, a little beneath the carriers, stands an employe who disengages the upper part of the inclined plane in order to facilitate the dumping of the succeeding packages, and who, on the contrary, pushes along the first that have arrived near the bottom of the magazine and the inclined plane, where they accumulate upon a movable panel. This first sorting can be carried on continuously if the influx of the packages requires it. The putting into hampers and final classifying is done but shortly before the starting of the trains, so that the tracks shall not be incumbered. Naturally, but a single magazine, corresponding to one train or a group of trains, is emptied at a time, and into this an employe descends in order to open a panel in front of which no package is found, thanks to the combination adopted for the motion of the discharging strake. The employe who has descended into the magazine, pushes through the aperture all the packages that present themselves, and thus gradually empties the magazine by advancing from panel to panel and opening it. The packages fall upon an endless belt that carries them to the sorters; but the man in charge of the magazine places them more or less compactly upon the belt, according to the number of such employes, and, in doing this, is guided by lines painted upon the belt as datum points. This belt, in fact, moves at a speed of one meter (3¼ feet) a second, and is capable of discharging 3,600 packages an hour. It ascends and reaches a sorting table situated at 5.35 meters (17½ feet) above the car-loading platform. From the table upon which the packages are deposited by the belt, the sorters can send them in seven directions, either through six chutes or through the prolongation of the belt, which is barred by a strake, in order to force the packages to fall into another chute. In this way all the packages become grouped upon tables, around which stand the hampers into which the employes are to stow them and close each one when it is full. All this work is done with surprising rapidity. It is even possible, owing to the combination of the different chutes, to interrupt the sorting at the second story in order to receive packages on the first designed for the same train, and afterward to resume the sorting on the second.

Let us now see what is done with the packages designed for the loaded cars. At the moment at which the sorters of the first story receive from the belts the packages marked 0, they deposit them upon a carrier arranged above their head. These packages likewise are to be stored, but in aerial framework hoppers, which are situated in the rear of the distributing chutes for hampers, and at a height of about five meters (16½ feet) along a platform at which stop the cars that are to receive the packages through their sides. From the carrier, which is above the first sorting table, the packages are dumped upon another, which carries them out of the subterranean chamber, after which they are received by a transverse belt that carries them to the special sorting table for the loaded cars, whence they are directed to the hoppers corresponding to the said cars. These hoppers are six in number. The first of them, the one nearest the sorting table, receives the packages directly through a chute, and the others by belts. But things are so arranged that it is unnecessary to install as many belts as hoppers. There are, in fact, but two belts, one of which, of three times the ordinary width, is designed

for the reception of packages upon its first, second, or third part, according as they are designed for the second, third, or fourth hopper. The other belt is of but double width, and is consequently provided with distinct spaces for the fifth or sixth hopper. If we follow a package designed for the second hopper, we shall see it dumped directly into the chute of this hopper by a movable strake. For a package of the third hopper, a fixed strake will push it upon the first third of the belt, when, afterward, a movable strake will dump it into its hopper, and so on. As for those that are placed upon the second belt, which naturally runs to a certain height above the other, some are situated upon the first half of it, and, after it has reached the end of its travel, fall, through a chute, upon the second third of the large belt and are then deflected to the first third by a strake, and finally dumped into their hopper, while the others first pass through the third third of the large belt and finally reach their magazine. As for the descent of the packages from the hoppers into the car, that is effected in a very simple manner, through a movable aerial chute.

In order briefly to give an idea of the advantages assured by this remarkable system, we may say that, with one-half the men, it has been found possible to ship twice as many packages as before. As for the daily and supplementary expense of electricity resulting from the adoption of this system, that does not reach 21 francs.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

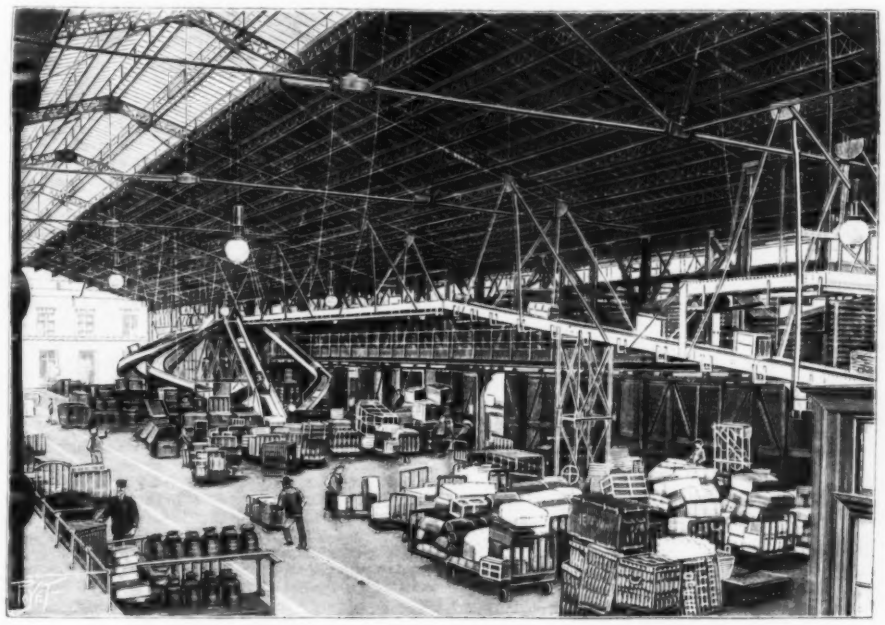


FIG. 3.—PUTTING THE PACKAGES INTO HAMPERS.

MECHANICAL STOKERS.*

By EDWIN FITTS.

THE greatest loss in hand firing occurs just after the charging of fresh fuel in large quantities and it is due to the fact that there cannot be a sufficient supply of oxygen brought up through the bed of fuel to supply the excessive demand at such times. The smaller each charge of fuel is and the less time elapses between charges, the less are the variations in the quantity of air demanded. This brings us to mechanical stoking, and an almost continuous supply of fresh fuel, requiring no variation in the quantity of air supplied, with the added advantage that there is no opening of fire doors with the accompanying loss.

FIRST STOKER PATENTED IN 1841 IN ENGLAND.

As to the history of mechanical stoking we may note that the first to use the idea of progressive burning of coal was James Watt. He distilled the coal on a dead plate at the mouth of the furnace and then pushed the coke back over the grate area by hand. In this way a fairly good combustion can be obtained, but the labor is very excessive. Many variations of this plan were brought out from time to time, but the first mechanical stoker was patented in 1841 by John Juckes, an English inventor. This was of the tread mill type and is in extensive use to-day, having been changed in detail of construction, and is now known as the chain grate stoker. There are a number of different makes of chain grates on the American market, and for fear of being considered biased toward one maker, I will describe them as a class.

The term treadmill type comes from the fact that the grates are built like the apron of a treadmill and pass over sprockets at the front and rear of the furnace. The grate surface is horizontal and the grates are moved from front to rear on the top, by power applied to the front sprocket shaft. Immediately at the front of this grate surface is a hopper extending the entire width and having at its back side a plate, which can be raised and lowered to govern the thickness of the bed of fuel. Immediately back of this hopper and extending the entire width of the grates is a firebrick arch. The proportion of the entire grate surface covered by this arch varies in the different makes of chain grates. In the operation the hopper is filled with coal, which is carried back by the movement of the grates and begins to burn as it comes underneath the igniting arch. The bed of fuel continues to move back until it reaches the rear end of the grates, when what is left is dumped over into the ash pit below. The fuel bed is not disturbed in any way during the period of burning.

THE MURPHY THE FIRST AMERICAN STOKER, 1878.

The first distinctly American invention of a mechanical stoker was the Murphy, brought out by Thos. Murphy, of Detroit, Mich., in 1878. Besides being the first American stoker, the Murphy was, I believe, the first invention in which a sloping grate surface was used. The sloping grate stokers of to-day can be divided into two classes, the side feed and the front feed. Of the side feed type we have two, the Murphy and the Detroit.

The Murphy stoker consists of two coal magazines, one at each side of the boiler, which form a portion of the boiler walls and extend back a depth depending on the grate area demanded. The bottom of these magazines is a flat plate built up of castings and steel angles in such a way that the top surface where the coal lies is cast iron and directly beneath this is an air duct. Lying on top of this plate, called the coking plate, are inverted rectangular cast-iron boxes having racks on their under side at each end. Beneath these boxes is a shaft extending the entire depth of the furnace and having segments of gears which mesh with the racks on the stoker boxes above. As this shaft is rotated through a small arc by means of an arm at the front of the furnace the stoker boxes are moved from side to side on the coking plate. As the box moves toward the center of the setting a charge of coal is pushed out toward the edge of the plate. Resting against the edge of this plate and sloping down to the center of the furnace at an angle of 40 or 45 degrees are the grate bars. Running along the center of the furnace is a heavy cast-iron bearing bar, upon which the grates rest at their lower end. Supported by this bearing bar and taking the space between the lower ends of the grates is a hollow cast iron bar, having projections on its outer surface, which is made to rotate and grind the clinker into the ash pit below. The grates are straight casting and are made in pairs. One grate of each pair is stationary and the other is made to rise and fall about 2 inches at its lower end. Forming the inner side of the coal magazine and coming down to within 5 inches of the coking plate is a heavy ribbed casting known as the arch plate. Extending the entire depth of the grate surface and resting on the arch plates at each side is a firebrick arch. This arch is built with an air duct on its upper side, which is connected with the outside of the furnace by means of the passage in the coking plate already mentioned and with the fire space by means of small openings in the cast-iron skew backs, on which the arch rests. The object of these passages is to admit hot air above the coal at the point where the volatile matter is driven off. The moving parts of the stoker are all actuated by a small engine standing at one corner and forming part of the stoker itself. This is made to drive a reciprocating bar extending across the front and connection is made to this by removable links. Any one part can be operated independently of all other parts. A distinctive feature of this type of stoker is the large coking space per square foot of grate area. This description covers the Detroit or Morrow furnace in all but one particular. In this stoker the coal is fed to the fire by means of a screw at each side.

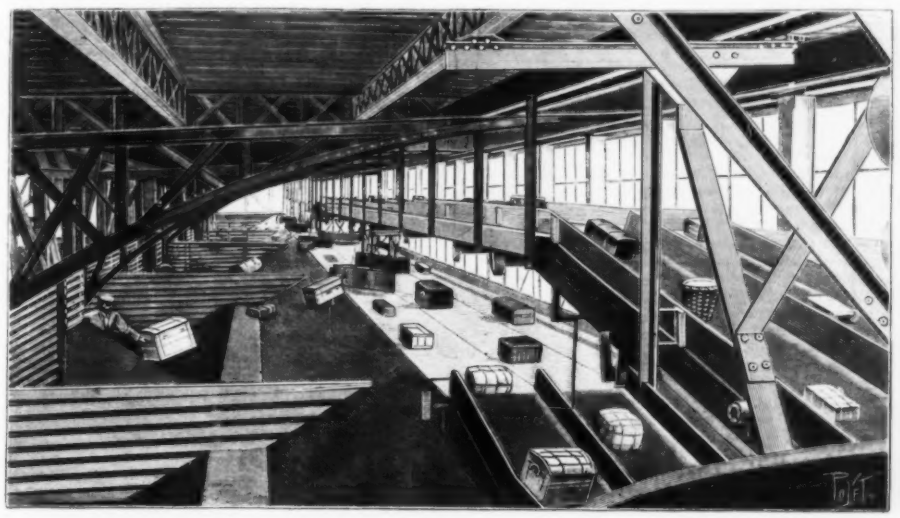


FIG. 4.—AERIAL MAGAZINES FOR LOADING A TRAIN OF CARS.

FRONT FEED TYPE OF STOKERS.

In the front-feed inclined grate stokers there is a coal hopper extending across the front of the boiler and having at its bottom a "pusher," which is given a reciprocating motion, and pushes the coal out at the lower side of the hopper on to a dead plate, where it begins to ignite. As the coal is moved out into the fire space it gives up its volatile matter and the solid portion is forced on to the sloping grate surface and burns there. Immediately back of the coal magazine and extending from side to side of the stoker is a short firebrick arch.

These features are common to all makes of this class, but, of course, there are variations in the details of construction. In the Roney, which is the most widely known of this class, the grates are so arranged as to form a series of steps extending from the dead plate down to the dumping grate at the rear of the furnace. These grates extend from side to side of the stoker, and by means of a mechanism at the front are made to assume the stepped and an inclined position alternately. This allows the fuel to gradually move down the grates and the refuse is finally deposited on the dumping grate, from which it is removed from time to time by the attendant.

The Brightman resembles the Roney very much. The grates are straight bars having lateral lugs on each side which overlap the lugs on the next bar when in position. These bars lie in the furnace in the direction of the axis of the boiler and each alternate bar is stationary. The movable bar is given a slight horizontal motion and the fuel bed is thus agitated and made to move down the incline of the grates. At the rear of this incline is a clinker basket, into which the unburned material drops from which it must be removed by the operator.

The Wilkinson is another stoker of this class. The feature of this stoker is its grate bars, and the means used to introduce air to the bed of fuel. Each grate is a hollow casting having the top surface a series of steps. In the riser of each of these steps is a slot. At the upper end of each grate is placed a small steam nozzle, which serves to inject air into it and so by slots out into the bed of fuel. The grates are given a slight reciprocating motion in order to force the fuel down the incline. At the rear of the grates the unburned portion of the fuel falls into a closed ash pit.

A number of other front feed stokers have been placed on the market from time to time, some of which are now manufactured, while others have proved total failures from either an engineering or business standpoint. The ones that I have mentioned will cover the general features of construction.

UNDER-FEED STOKERS.

All stokers so far mentioned can be brought under one head and termed over-feed. Another type in which an entirely different principle is used is known as the under-feed. In this case the fuel is forced up from underneath and burns on top of a heap, which forms in the middle of the furnace. A volume blower is used and air is forced up through the heap of coal from openings in tuyere blocks which are located at the point where the fuel is supposed to give off its volatile matter. There are two makes of this class of stoker. In the Jones the coal is forced in beneath the heap in large charges by a steam ram. The American is a copy of the Jones in all but its feeding device. Instead of a ram, a cone-shaped screw is used, being driven by a small reciprocating steam motor. All stokers of the underfeed type must have the unburned refuse removed through the front of the furnace, in the same manner as in hand firing.

MECHANICAL STOKERS PREVENT SMOKE.

In making a comparison between mechanical stoking and hand firing, the most noticeable item is the smoke,

* From a paper read on March 3, 1903, before the Mechanical Section Engineers' Society of Western Pennsylvania.

With a properly constructed stoker used in connection with a stationary steam boiler having its heating surfaces and passages for gases properly designed and constructed, no smoke should issue from the stack, whether the fires are being cleaned or not. Of the cloud of smoke hanging over the city of greater Pittsburg, about 75 per cent comes from soft coal burned under stationary boilers. Of the smoke so made, 98 per cent can be avoided and a saving of at least 15 per cent be made in the cost of steam generated.

A point that has often been made against mechanical stokers is that they will not work a boiler to its full capacity. This may be true of a stoker in which the bed of fuel is not disturbed, allowing the clinker to cement together and thus shut off the passage of air through the fire. But with a stoker which is self cleaned, having its entire grate surface free from clinker at all times, there is no trouble in working a boiler from 40 to 60 per cent above its normal rating and securing good economy and smokeless combustion.

Here is a point that should be considered in first cost of plant. You may have a 500-horsepower boiler and decide to put in a certain stoker, because it costs less, that will not work the boiler to more than 10 per cent above rating. Another stoker, which may be a little more expensive to install, will work the boiler easily to 25 per cent above its rating, giving good economy, and in case of a sudden demand can be made to force it to 50 per cent or more above rating. In both cases your boiler cost is the same, but in the first case you have but 550 horse power, while in the second you have 625 and can get 150 horse power or more. It is very easy to see which is the cheaper when cost per horse power developed is considered.

THE SAVING ACCOMPLISHED OVER HAND FIRING.

As to the saving that can be made by the use of mechanical stokers, about the only reliable figures are those taken from the books of manufacturing concerns where an account is kept of the boiler house expense per unit of output. These figures can generally be obtained from the manufacturers themselves, but could hardly be embodied in a paper of this kind. When fuel alone is considered, the saving will seldom fall below 15 per cent; and in large plants when the total cost of maintenence is considered, including labor and cost of repairs, the saving will be much above this.

In 1895 an investigation was carried on at the Ohio State University, which is of much value in this connection. A series of tests was made to determine the amount of saving that could be made by stoker firing over hand firing. The conditions were as near alike as possible in both cases. When the same high grade of coal was used for both methods a saving of 16 per cent was found in favor of the stoker. When a cheap grade of coal was used in the stoker and an expensive smokeless coal for hand firing, a saving of 50 per cent was shown in favor of the stoker. A number of other comparisons between different coals were made and the results were embodied in the report of the university trustees of that year.

The strenuous advocates of hand firing will point the finger of scorn at the many so-called total failures of mechanical stokers. But did they ever look into the cause of these failures? I will admit that schemes of stoking have been invented that were not practical, but this is not saying that the whole subject is impractical. I have in mind now a case where an entire stoker equipment was condemned and thrown out because the arm on the damper shaft was not put on parallel with the damper. They tried to work the fires, supposing the damper to be open, and when they could not of course the stokers were at fault. They tried hand firing with the same result, and then found the cause. Cases of this kind were formerly of frequent occurrence. One thing that is often met with is a boiler plant having good boilers and stokers and a stack insufficient to give ample draft. Connecting the boilers and stack will be a flue so constructed that the draft is almost entirely shut off. If your boiler plant is not giving you satisfaction, look it all over, and the chances are, if you have been wise and bought a good stoker, that you will find the trouble at some other point.

The question to-day is not "Shall we use a stoker?" but "What stoker shall we use?" This is true no matter what the size of the plant may be.

NEW VIEWS OF THE CONSTITUTION OF MATTER.*

By Prof. F. C. Robinson, of Bowdoin College.

There is something very attractive about theorizing. Especially attractive is it to one who is constantly engaged in experimental work. He sees the infinite complexity of things, and it is a relief to leave all this and pass into the region where all is simple and plain, "where all the rough places are made smooth and the crooked made straight."

But it is a dangerous region for a scientific man to enter, and I dare not venture too frequently into it, for fear that, like some others, I may get lost and never come back to the region of actual things. There is no more hopeless condition for a man of science to get into than that of constantly theorizing, of constantly asking why instead of how. We are all familiar with the long-suffering parent and inquisitive small boy. "Papa, why did the man do that?" is his constant refrain. He is a type of the theory hunter in nature, and I think the one gets about as much valuable information as the other. The comparison can be carried even further, for in both cases the questioner, as a rule, does not know enough to understand an answer when given. American science in the past, and especially American science teaching, has had too much *why* in it and too little *how* and *what*. It is the rarest thing in the world for a discovery of importance to come from knowledge of a theory alone, and that is why we have made so few scientific discoveries and the Germans so many. The recent controversy resulting from the criticism of certain popular books about animals is a case in point. The real scientific spirit has made so little progress among us that all a skillful writer needs to do is sit in his study and evolve from his inner consciousness a most novel and astounding theory of animal action, and it is readily accepted and taught as the veriest gospel truth. It is one of the most necessary lessons for a would-be sound thinker in any line that a theory is not a fact, no matter how venerable it may be, or with what great names associated.

And yet I purpose to talk to you this evening about certain theories concerning matter. Perhaps I have not magnified my subject much by thus disparaging theories. But I am speaking to scientific men, to men whose whole training and success depend upon knowing how and what, with the why always of secondary importance. So I am sure what I have said does not strike you as novel and unheard-of, and will not affect your minds unfavorably toward anything else I may say. Indeed, I think it will do just the opposite, giving that feeling of satisfaction which always comes when our own thoughts and actions receive the stamp of approval from some one else.

Of all subjects theorized about none has been more popular than the constitution of matter. "What are material things in last analysis?" has been the question from time immemorial. I need not, before this audience, enter at all into details of the various theories propounded to answer that question. You not only know them, but you know perhaps how much more sure men once were that they had the right answer than they are to-day. It is one of the characteristics of ignorance that it is very sure of its position. It is also one of the profoundest of truths that the more we know about a subject the less easy it is to fully and satisfactorily explain it. This is especially true of subjects connected with material things.

Of course such a statement may easily be misunderstood. It is not that the more we study the less we know, but the more we learn about things the more we see there is to know, and the less easy it is to form satisfactory theories about them.

It generally happens, too, that after a theory in science has been strengthened and buttressed about by fact after fact, so that it seems impregnable, there is a sudden and unexpected development of new facts which threaten the very foundation of the structure.

The old doctrine of combustion is a case in point. The theory was that fire was a material which entered and left bodies, giving rise to all the well-known phenomena of burning. From being vaguely suggested, it passed to definiteness of expression. It seemed to explain satisfactorily all the facts known, so that Priestly, the discoverer of oxygen, in explaining the properties of what we now know as nitric oxid, said, "If any opinion in all modern doctrine about air be well founded it is certainly this, that nitrous air (the name then given to it) is air charged with phlogiston (the name given to the heat element), and that from this quality only it renders pure air noxious. If I have completely ascertained anything at all relating to air it is this." But at that very time he had himself discovered oxygen, the substance which made it necessary to abandon that theory so "completely ascertained."

Theories of the constitution of matter have met with similar fate. There was first the theory of all things, made up of four elements, earth, air, fire, and water, and these in turn made up of non-material principles, heat, cold, wetness, and dryness; cold and wetness forming water; cold and dryness, earth; heat and wetness, air; heat and dryness, fire. This was in general the theory of the old Greek philosophers. This was followed by or grafted on to the theory of the alchemists of the middle ages, who regarded all material things as composed of a trinity, "a body and a soul held together by a spirit, which is the cause and the law." This "soul of matter" they believed to be the transforming principle, the "middle nature" referred to in their writings. It was the same in all matter, and they believed that, if they could extract it pure, they could transform grosser matter into the purer forms of which gold was the best type.

Even after this purely mystic conception of matter was abandoned, and the alchemists had passed away, or at least ceased to be the leaders in natural science, the theory of immaterial principles was held to as giving the properties to matter. A substance was supposed to be sweet because it contained the principle of sweetness, and sour because it contained more or less of sourness. The poisonous principle and the healthful principle gave their properties to whatever they entered.

It was the chemical balance which did the most to overthrow the idea of immaterial principles going from one substance to another. It showed that there was no such thing as destruction and creation of matter, that different properties in substances depended upon different definite amounts of matter added to or taken from them.

By the work of John Dalton the atomic conception of matter soon came in, and the theory of it as composed of indivisible atoms, and owing its properties to the grouping of these into bunches of various kinds, was elaborated. That is the theory that all of us, I suppose, have been brought up upon.

Now I am not here this evening to demolish the atomic theory. It still remains in spite of some attacks upon it as the one which best satisfies the conditions. In fact, it is impossible for me to see how very many facts about matter can be interpreted without it. When I speak of attacks upon it I do not refer to those revivals of medieval ideas about the nonexistence of matter. Such have taken place at intervals ever since their general abandonment by scientific men.

Every little while some one evolves, or pretends to, some theory of material things, usually for religious use, along those old lines, and it serves its purpose for a longer or shorter time. There is no use in these days of arguing against it; indeed, all argument for or against is out of place, because it always comes as a "revelation" and not as a result of scientific processes. In reference to such things the remark of the old English chemist, Thomas Vaughan, is apposite: "Nature moves not by the theories of men but by their practice, and surely wit and reason can perform no miracles unless the hands supply them."

The chief imperfection of the atomic theory has always been the constitution of the atoms themselves. It has, from the first, seemed impossible to get much light upon this point. It was assumed by Dalton that they were solids of different shapes, corresponding to the geometric solids, cube, octahedron, etc. These were supposed to have attractions for each other similar if not identical with magnets. But the forces evidently originating in the atoms, electricity, magnetism, heat, light, etc., decidedly negative any idea of solid atoms combining into fixed static systems. They must certainly be the seat of complex motions, not only of translation like projectiles, but of vibration or rotation or both. These motions have been calculated, and must be enormously rapid.

Such motions, of course, cannot be measured in the ordinary way. If they could, the theory would be changed to fact. One reason is the necessary smallness of the atoms. They elude the search of our most powerful microscopes; indeed, are so far beyond them in smallness that there is no hope of ever proving their existence by that means. For example, our most powerful microscope will perhaps distinguish an object one-thirty-thousandth of a centimeter in diameter, about one one-hundred-thousandth of an inch, while atoms cannot be larger than one-thousand-millionth of a centimeter or one three-thousand-millionth of an inch in diameter. A microscope would need to be at least ten thousand times as strong as now in order to detect such objects.

The same kind of mathematical necessity shows that if the physical forces have their origin in the movements of such small bodies these movements must be very rapid and varied. Of course these motions must depend upon the state of the matter with reference to temperature, also whether solid, liquid, or gaseous.

It is more practical to measure the motion of atoms of gases. The hydrogen atom at ordinary temperatures would need to move among its fellows about one mile per second, and vibrate to produce light (or revolve) from 400,000,000,000 (four hundred billions) times a second up. Evidently the very careful inspection of such particles would be rather difficult, even if one had a microscope of sufficient magnifying power.

As the study of electric phenomena progressed, it became necessary to assume that around each atom was an electric envelope of some kind, and that electric phenomena in matter were connected with this, an electric current being due to the movement of this envelope from atom to atom through a conductor. The envelope was regarded as positive around some atoms and negative around others. Thus a very definite mental picture of an atom could be formed, that of a nucleus of matter in rapid motion, surrounded by an envelope of electricity conceived of as a very subtle fluid of some kind.

But are we entirely unable to form any reasonable conception of what these moving atoms are composed of? I mean any conception based upon experiment. Until very recently the only conception brought forward was that of Lord Kelvin, formerly Sir William Thompson. He suggested that they were all composed of the same thing, and that the ether or medium which fills all space not occupied by matter. You are well aware that all scientists now believe that between the particles of all matter is this non-matter called the ether. This is the conveyor of energy, like light, heat, etc., from material to material. Matter in certain conditions can excite waves in this or pulsations which go on to other matter. By this light and heat come to us from the sun and other bodies. Matter in motion moves through it without disturbing it, with no friction at all, and can only excite a wave in it when in such rapid motion as indicated above, or through electrical disturbance.

Lord Kelvin's suggestion was that the atoms of matter were made up of separate portions of this ether endowed with motions, first with a general and common-to-all vortex motion like that seen in rings of smoke projected suddenly from a round opening, and second with vibratory motions of different kinds. The atoms of a given element would all have the same kind of motion, which, once given, could never be changed except by the same force which originally started it. These atomic motions would never stop of themselves, because there is no friction in the ether.

This idea was a mere speculation, but the speculation of an acute scientific reasoner. It never could be quite dignified by the term theory, for there were not facts enough to base a theory on.

But within the last year or two unexpected light has been thrown upon the composition of atoms, and it has come from electricity. Measurements of size and motions have been made, which were not thought possible but a few years ago.

Curiously enough, too, the first advance came in connection with a phenomenon thought to be fully explained already, the phenomenon of the cathode rays. You will remember that these are the rays which appear in partially exhausted glass bulbs or tubes called "Crookes tubes." They are not the modern X-rays of Roentgen, but rays which develop before the exhaustion is carried so far, and do not pass out through the glass, or but slightly; rays which cause the phosphorescent glow in the tubes, both on the glass and other substances.

Crookes ventured the suggestion that they were matter in another form, a "fourth state," as you will remember, some of you at least, but that idea was not received with favor, and little was heard of it later. The settled opinion came to be that they were residual atoms of the gas which originally filled the tube rapidly projected from the negative pole and carrying their charges of electricity with them. They were believed to be in the same condition as atoms of substances in a solution when an electric current is passing through it, that is, separated from each other and moving through the fluid, those carrying positive electricity to one pole and those carrying negative to the other. Of course they would move more rapidly in the Crookes tube because there were so few of them that collisions would be less frequent. An interesting part of this is that mathematical demonstration was supposed to have proved that the cathode ray was a stream of atoms electrified. This was proved by a beautiful experiment whereby the electrochemical equivalent of the stream of particles was determined, being calculated from their

* Paper read at the Fifty-eighth stated meeting of the Maine Academy of Medicine and Science.

velocity and the amount of their attraction by a magnet of known strength according to the formula $\left(\frac{M}{E}\right) v = Hr$, where H is the magnet strength, r the deflection of the stream, and v the velocity of the particles. These three factors being known, $\frac{M}{E}$ — the electrochemical equivalent was found. But it was another case where the figures didn't seem in accord with the facts, and when J. J. Thomson recently examined the whole matter anew in the light of new experiments he found the mistake.* It was in assuming that the velocity of the particles was that of atoms in a gas at the given temperature, which, of course, it should be if they were atoms. That velocity is about one mile per second. He found, on the contrary, that the actual velocity of the particles was from ten thousand miles per second up to eighteen thousand.

Now bodies moving with such tremendous velocities, even though very small—as small at atoms—would exert considerable energy when suddenly stopped, and we all remember the mechanical effects which are seen in Crookes tubes, the propelling of a windmill, the heating of a piece of platinum, etc. But when Prof. Thomson actually measured the energy by transforming it into heat, and compared it with the amount of electricity carried along, he found that they did not compare as they should on the theory that they were ordinary atoms with their electric charges. There was too little energy for the amount of matter, or too much electricity.

He found, in brief, that the particles carrying the electricity must be about one thousand times lighter than the atoms of hydrogen, and presumably at least so much smaller.

Here, then, was experimental evidence of the existence of particles many times smaller than atoms. But what are these particles? Is the atom smashed at last—the indivisible divided? It would seem so.

But more suggestive experiments followed. Taking advantage of certain experiments of the Germans, Hertz, Righi, and Elster, showing that violet light would cause the discharge of negative electricity from a charged plate, and that a magnet would deflect the rate of discharge, acting upon the electricity much as it does on the cathode rays, Thompson devised an experiment which deduced the same electrochemical equivalent that the cathode rays gave. The negative current here seemed to consist of particles of the same magnitude as those forming the cathode rays. Could it be that the cathode rays were actually nothing but pure electricity, or that electricity consisted of particles, was an actual substance and not a mere impulse in the ether? It certainly seemed so.

He got a further confirmation of this idea by actually making the electric particles show themselves, or so nearly do it that they could be counted. This was done by making them act as nuclei for mist particles.

It has been proved that water never forms into actual raindrops without particles to form around. Every drop of rain has at its center a particle of some kind. Thomson succeeded in making particles of electricity act as such nuclei for water, and the resulting mist particles were counted. The results agreed with the previous experiments. These experiments leave no escape from the conclusion that atoms can be broken up into much smaller fragments. They do not prove that these fragments are simply particles of electricity. In all the experiments there may have been present with the electricity a fragment of matter.

When we consider for a moment how electricity is generated, it seems, at first sight at least, that it could not give any of the mass effects of material substance. But let us examine more closely. When two bodies are brought together and then separated, what is called an electric field is formed between them, that is, the medium between them is under a strain, tending to bring the bodies together. There is really no electricity or electric current between them, only a strain or stress as though they were connected together by elastic bands. The electricity is all at the ends on the bodies. If the bodies move the strain moves with them, not the ether; that remains rigid. They pass through it or it through them without any friction or resistance at all. But the ether left behind does not at once come back to its original condition, neither does that ahead of the motion take up the strain instantly. It takes time to adjust itself and in the adjustment magnetism develops. This magnetism acts upon the ether in its neighborhood, producing another strain, which has two effects, one to send pulsations through the ether with the speed of light (these are the ether waves by which wireless telegraphy acts), and the other to cause a current of electricity to pass through a conductor properly placed, but in the opposite direction to the original current. We have, then, in such moving bodies first the original ether strain or electric field surrounded by its magnetic field, and this in turn accompanied by another ether strain which will cause a current opposite to the first. This is the induced current, so-called, which does the work on our electric railroads, etc. These currents oppose each other or perhaps rather the magnetism between them tends to stop them, so the more the induced current is carried off the more magnetism there is to pull back, and the harder it is to keep up the motion of the generating bodies, or rather body, for in practice the revolving armature is the moving body. Thus we see in a central station how much more power it takes to turn the armatures of the dynamo when more current is drawn off by the wires. We see nothing at all to impede its motion, but it behaves exactly as a saw does when being forced through a log. The inertia being overcome by the revolving armature is electric and not material, but the behavior of the two is very similar. Electricity, then, may cause inertia when in rapid motion. But the particles moving in the Crookes tube are in rapid motion, and must likewise be accompanied by magnetic fields and induced currents, and so their inertia may be due to such a combination, and the necessity of having matter with them to account for their heating effects is avoided.

But if it is not necessary to suppose anything different in this case, why must it be in any case? Why may not the material atom itself be simply a collection of these electric particles, and so all matter be resolved into electricity? This, indeed, is what is now being claimed. According to this view there is nothing really in the physical universe but electrons and ether, and perhaps, as in Lord Kelvin's idea, the electrons are made of ether.

The elementary atoms are groups of these electrons, which are of two kinds, positive and negative. Different numbers make different atoms. Thus the hydrogen atom may consist of about 700 while the mercury atom consists of perhaps 100,000. These electrons, except for being positive and negative, are exactly alike; the different numbers grouped in different motions make up the different kinds of matter. One would suppose that, where so many are crowded together in such a small space as that of an atom one three-thousand-millionth of an inch in diameter, they could not be very free to move, but quite exact calculations show that the space not occupied by them is at least ten thousand million times as great as that occupied, so they must be as free to move as the planets in their orbits and collisions between them about as rare. It is supposed also that around each group making an atom are certain loose ones, so to speak, electrons less firmly held, which may be pulled off by neighboring atoms just as comets may be drawn into our system when they get near enough. These cause electric currents and chemical attraction, etc.

It would seem that an atom composed of such a moving collection could not be very stable, that it might disintegrate, and these electrons all fly away to other atoms or remain free in the air. Curiously enough, that seems to be just what we are finding out does happen, especially in the case of the negative electrons. The positive seem to be less liable to do this. Thus, as we have seen, the influence of an extra charge of negative electricity sends free negative electrons streaming through the Crookes tube. A ray of violet light separates them when collected on a surface. It is believed that when a gas conducts electricity it always does it partly by free electrons coming from break-up of atoms. In all these cases there is an impulse or shock which frees them, but in many substances they seem to come off spontaneously. Several new substances, radium, polonium, etc., give of themselves constant discharges of electrons, and almost every day some new substance is discovered which does this. Thorium and its compounds, uranium, hydrogen dioxid, and many others, give off constantly these radiations believed to be due to breaking up of atoms and sending out of their electrons. It would seem as though the air must be full of these floating electrons.

One of the necessary results of this theory seems to be that we must give up the old idea of the indestructibility of matter. Some of it must be constantly undergoing destruction, and the flying fragments are bombarding us on every side. And these flying fragments hit hard, too, if there are enough of them. A minute fragment of radium inclosed in a tube and put in the pocket would soon raise a blister on the skin underneath the clothing, and it has been estimated that it would be as much as a man's life is worth to go into a room where two pounds of radium was kept in a case. Fortunately there is no prospect of such a quantity ever being obtained. But why have our delicate balances never yet been able to detect this destruction of matter? Because they are not delicate enough. We cannot weigh the perfume of a rose and yet we know it is material. We cannot weigh as small bodies as we can see with our microscopes and we know how much smaller atoms are, and how much smaller than atoms electrons are.

It is estimated that the rain of electrons in a Crookes tube would need to be kept up one hundred years before the material carried could be detected as gain or loss of weight by our most delicate balances. But this destruction of matter is not real destruction, in one sense at least. It is a breaking up of material atoms, but these fragments still exist and may group themselves or be grouped into material atoms again.

The most puzzling thing about the whole subject is, whence comes the energy which supplies the motive power by which a substance like radium keeps up its constant discharge of electrons? Must we conclude that our theory, long held, of the conservation of energy is untenable also? It is not at all necessary to do that. But we must enlarge our ideas of the possible sources of force. For a great many years all the forms of energy we were acquainted with could be resolved into the well-known forces, heat, light, electricity, magnetism, gravitation, chemism, and it is hard for us to think of the possibility of other sources. But it has always been held that there possibly were atomic and molecular motions not manifested in such ways, and now, perhaps, we are seeing evidence of these. There certainly is plenty of unused energy in nature. Consider for a moment the energy in the atoms of what seems to be perfectly quiet air. Instead of being matter at rest, it is made up of particles moving with enormous velocities. A cubic yard of quiet air possesses an energy equal to one hundred and forty thousand foot pounds. We get no evidence of this and cannot utilize it because it is used up in collisions among the atoms themselves. The swiftly moving atoms strike the slower moving, and energy is changed from one to the other, but the temperature of the whole remains the same. If there were any way by which the slow moving could be rapidly separated from the mass, the residue would grow rapidly hotter and energy would seem to have been created, but really it would not have been. It is the energy already existing, made manifest. Now it is conceivable that radiating substances like the new element, radium, are sensitive to the impact of atoms moving at a certain rate, and not to others. Thus the ceaseless stream of energy they send out is not self-manufactured from nothing, but comes from changes in other matter which hitherto we have been unable to utilize.

If this be true, and some lucky discoverer finds out why and how it does it, and succeeds in improving upon this, constructing a substance which will have this power many thousand fold, a revolution in motive power will have been made which almost swamps the imagination.

Instead of looking to steam and water power for our industrial service, we should simply expose our radiating material, and it alone would run our factories or heat or light our rooms, and we at last be free from the pressing fuel problem.

But, as I said at the beginning, theorizing must be checked or it will run away with us, and I fear these last ideas may indicate that I am perilously near that condition now. Remember that this electron theory is still but a theory, and in its infancy at that. But I believe the facts on which it is based will be enlarged rapidly, and that very many practical results will be worked out from and by them to the great benefit of man in his struggle with material things.

* See recent address on "Electrons" by Sir Oliver Lodge in SCIENTIFIC AMERICAN SUPPLEMENT.

ON POLONIUM AND THE INDUCING CHARACTER OF RADIUM.

By F. GIESEL.

IT has been found by Marckwald (Berichte, 1902, xxxv., 2285, 4239) that metallic bismuth which is immersed for some time in a hydrochloric acid solution of Curie's bismuth polonium acquires to a remarkable extent the property of emitting α-rays. Marckwald considers that the precipitate formed on the bismuth consists, at any rate in part, of metallic polonium, and regards the electrolytic separation as the proof of the existence of an (electro-negative) element differing from bismuth and allied to tellurium.

I (Berichte, 1902, xxxv., 3608) was successful in confirming Marckwald's observation with my purified polonium preparations, only no trace of a precipitate or a coloration was to be seen on the bismuth. As the non-appearance of a precipitate seemed to argue against Marckwald's theory, and in any case the prospect of obtaining sufficient quantity of the element in question was very remote, I tried to approach the question of the nature of polonium in a different manner.

In attacking this problem, I was guided by the opinion which I had previously expressed, that polonium may be bismuth acted upon inductively by radium, a view which was forced upon me by experience in direct experiments repeatedly performed when preparing preparations of polonium (Berichte, 1902, xxxv., 3610). As in my earlier experiments less attention had been paid to α-radiation, and I had recently found (Berichte, 1903, xxxvi., 729) that this was developed both in metallic bismuth and also in platinum and palladium by the action of a solution of bismuth polonium chloride, it was important to investigate how a radium solution would behave. It may be safely asserted that the clean surface of the metals guaranteed the possibility of perfectly removing every trace of the soluble primarily active reagent which cannot be vouched for in the case of precipitates even with the most careful washing. This appears all the more important when it is remembered that even one-half a millionth part of radium salt, present as an impurity, is sufficient to cause appreciable phosphorescence of the barium platinum cyanide screen.

In fact, it is now easily possible to impart to bismuth or the platinum metals, by momentary contact with radium, properties which exactly resemble those produced by polonium.

If a freshly cut piece of bismuth is placed in a solution of 0.01 gramme radium bromide in 1 cubic centimeter water, after remaining there for one to two days, the bismuth shows strong α-radiation and no β-radiation.

Note.—The non-appearance of β-radiation, after keeping for two weeks, may perhaps be employed as a control experiment for demonstrating the absence of radium. For testing for α-rays the zinc sulphide screen was used, and for β-rays the barium platinum cyanide screen. All α-radiation produces on the zinc sulphide screen the scintillation described by Crookes, and observed by Elster and Geitel, while the β-radiation appears to produce only uniform illumination. The effect of a current of air on the scintillation can only be observed in the emanation of my emanation substance (Berichte, 1903, xxxvi., 342).

The greatest possible care was taken to remove every trace of radium salt from the bismuth.

Platinum-wire and palladium-foil, before being introduced into the radium solution, were rubbed with emery and sea-sand, washed with hydrochloric acid and distilled water, and ignited. After treating with radium solution, like the bismuth, they were carefully washed with hydrochloric acid and distilled water to free them from the radium salt.

Bismuth is decidedly superior to the platinum metals in acquired activity, and seems to be best suited for accumulating the positive electrons of radium. It is noteworthy that the part of the platinum wire which was beyond the end immersed in the radium solution in the test-tube, and thus was only in contact with the air, also showed decided activity (α-radiation). The line of separation of solution and air was marked on the wire by a short zone of greatly diminished activity. The α-radiation thus artificially communicated by the radium to the bismuth, palladium, and platinum shows no decrease, as far as has been observed. As it has hitherto always been found that the activity caused by induction diminishes with the time, comparatively speaking quickly, it is of great importance to investigate the limitations of this law by the manner and kind of induction, for which a longer time of observation is necessary.

The small quantities of bismuth and palladium passing into the hydrochloric acid solution in the above experiments were precipitated with sulphureted hydrogen. The precipitates (especially the palladium sulphide), in spite of repeated washing, emit β-rays strongly. From what has already been said it could not be deduced whether this radiation is due to the adherence of radium; it can only be shown how it behaves with regard to the constancy of the activity.

I was able also to confirm the observation of the Curies, concerning the development of heat by radium, which can be proved in a very simple way.

If a thermometer is lowered into a glass flask containing 0.7 gramme radium bromide, in a short time it rises 5 deg. above the temperature of the surroundings, and remains at this temperature as long as it is kept in the flask. When held over a capsule closed with a

sheet of mica and containing 0.3 gramme radium bromide, the thermometer showed an increase of temperature of almost 2 deg., if it was protected from currents of air.—Berichte d. Deutsch. Chem. Gesell.

THE TRANSMISSION OF A 23,000-VOLT DIRECT CURRENT OVER A DISTANCE OF THIRTY-FIVE MILES.*

By EMILE GUARINI.

THE recent installation of a hydro-electric plant at St. Maurice, near Lausanne, Switzerland, represents the only one of its kind in the world. It is unique, without a doubt, being the only plant thus far erected from which a direct current is sent out at a tension of 23,000 volts and transmitted over a line 56 kilometers (34.77 miles) long. This power plant demands the attention of expert electricians because the Compagnie de l'Industrie Electrique of Geneva have, by its erection, violently set themselves against the tradition which demands the use of the alternating current, with its accompanying up-and-down transformers, for long-distance transmission, and have worked out the problem for the direct current by means of a series system invented by Mr. Thury, the engineer-in-chief of the company. Already, as early as the year 1898, with the intention of providing itself with power and light, wherewith to effect a considerable development of its industries, the commonwealth of Lausanne acquired the power to take from the Rhone River at St. Maurice a force equal to 15,000 horse power by utilizing the rapids of the Black Forest.

Having obtained the concession, it next became a question how to transmit this immense power safely and economically from St. Maurice to Lausanne, about 56 kilometers distant. Accordingly a call for competitive offers for the construction of such a plant was issued, and the expert electricians who were intrusted with the examination of the bids, and thereby with solving the knotty problem, after carefully weighing the different projects presented for the transmission of the required energy, some by means of a direct current and others by three-phase currents, did not hesitate to decide in favor of the system comprising a direct current in series. Their choice was determined first of all by the safety of its utilization, by a consideration for the more facile regulation of the light, and still more by the obvious economy of its construction. Indeed the capital required for the establishment of the first plant under the direct current in series-system proposed by the Compagnie de l'Industrie Electrique et Mécanique, was only 7,365,000 francs as compared with 8,105,000 francs for the installation of a three-phase-current plant of the same capacity, being a difference in favor of the direct current installation of 740,000 francs.

Accordingly the Compagnie de l'Industrie Electrique et Mécanique was commissioned to erect the first installment of the plant, constituting about one-third of the available power of the completed plant, say about 5,000 horse power, under the series system.

FIG. 1.—THE POWER-HOUSE AT ST. MAURICE.

plished a few months ago, was clothed with a character of veritable scientific and technical solemnity. The most distinguished representatives of the great electrical and mechanical reviews of the Continent were present at these interesting trials. The tests with a full load were attended with complete success at a tension of 23,000 volts under a constant intensity of 150 amperes. To do this there were provided at the receiving station, 56 kilometers away, a series of twenty large vats with circulating water for the absorption of this immense energy. Besides the direct-current machines for the sending of the electric energy over the long line, this generating station also contains two groups of three-phase dynamos, shown in Fig. 3, which produce the current used in lighting St. Maurice. The

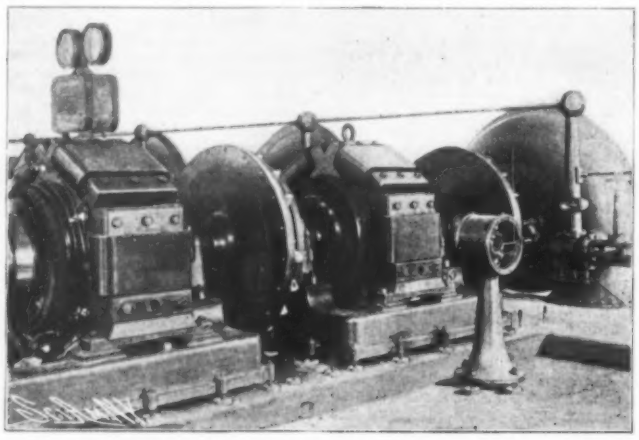


FIG. 2.—1,000-H. P. UNIT CONSISTING OF TWO DYNAMOS, EACH GENERATING A VOLTAGE OF 2,600, CONNECTED IN SERIES.

For the generation and transmission of this amount of power, there are required at the generating station at Saint Maurice, shown in Fig. 1, five 1,000-horsepower units, each consisting of two dynamos direct connected to each other and to a turbine. Under a full load each of these units will deliver 150 amperes at 4,500 volts.

Fig. 2 shows one of these units, each of the two dynamos of which, connected in series, generates a 150-ampere current at a voltage of 2,250. By connecting the five units in series, the total energy of the plant is obtained at a tension of 22,000 volts, the highest voltage for a continuous or direct current in actual existence. The foundations for the building have been erected upon the edge of the runway canal, and extended, with a view to the accommodation of the remaining two groups of units which will complete the 15,000 horse power at first intended. The inauguration of this most remarkable transmission of power, accom-

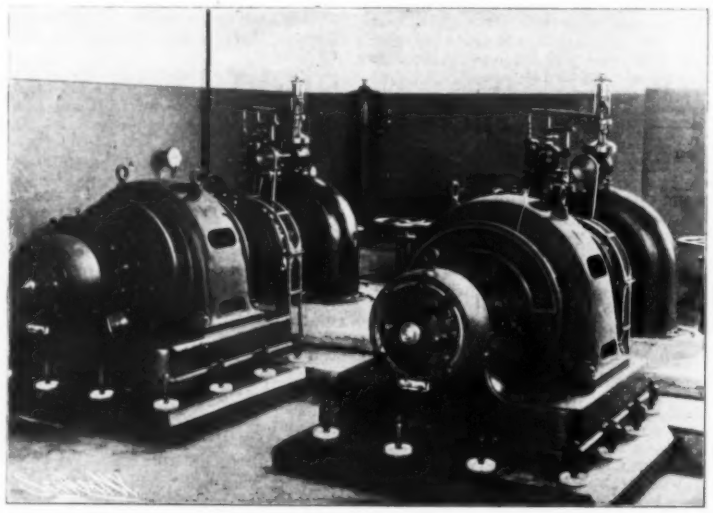


FIG. 3.—A GROUP OF ALTERNATING-CURRENT MACHINES (150 H. P.).

reader will no doubt remark that this installation of power appears to be verily a "world turned upside down," so to speak, in which use is made of the direct current for long-distance and an alternating current for short-distance transmission.

Each unified group of the direct-current machines carries a voltmeter and an ammeter mounted upon the frame of the field of one of the dynamos.

The distributing board of each group is reduced to a simple column shown in Fig. 4, inclosing a short-circuit switch, which permits the short-circuiting both of the general wiring system and of any unit of two machines at the same time, as well as the cutting of the dynamos out of the system altogether.

The stepping-in of any individual unit is a very simple matter, for by the gradual opening of the gate to the penstock of the turbine, the machine is slowly started and acquires shortly the necessary speed, being self-excited by short circuit.

When the delivery in the short circuit is equal to 150 amperes, the group is cut into the main circuit by the manipulation of the short-circuit switch, and this is accomplished without any sparking. At first the load of each unit is regulated by hand, but afterward the governor of the turbine is connected with the automatic governor which acts in general upon all the units of the plant. This voltage regulator is of the Thury type and is shown in Fig. 5. It receives its motive power from a small bipolar motor operated by means of an induced current derived from the main line. This motor, which runs at a speed of 1,700 revolutions a minute, requires a current of 50 amperes when running light and 60 amperes when loaded, at a tension of 2.3 and 2.4 volts respectively, which, by the way, is the floating voltage of a small storage battery connected in parallel, that forms a reserve in case there be any interruption in the main line.

In this case the armature of an electro-magnet falls upon the ratchet gear wheel of the regulator, which immediately assumes the position necessary to shut off the turbines; while the small motor continues its work, fed by the current from the storage battery. Of course the ultimate stoppage of a group of units is effected by cutting off the water power from the driving turbine, which is gradually brought to a standstill by the resistance of the now idle water about it, in which it turns, dragged around by the momentum of the dynamo, now acting as a motor; meanwhile the automatic switch short-circuits the dynamo. An ammeter, a voltmeter, and the connections which run to the lightning-arrester box constitute the whole of the main switchboard of the plant. Upon a visit to the receiving station at Lausanne we find the customary procedure in such a station has been reversed. Ordinarily, alternating currents are stepped down and converted into direct currents; but here in the establishment at Lausanne the direct current is converted into an alternating current. Installed in the building here are five direct-current motors coupled in series, of 400 horse power each, which absorb 150 amperes at 2,100 volts. Of these five, four are coupled direct to alternators, whose function it is to distribute the electric energy through two specially provided circuits, one for the electric lighting, and the other for motive power, serving at one and the same time the city of Lausanne and the surrounding districts.

In Fig. 6 we present a view of one of these groups. Two of these alternators may equally well be coupled with Sulzer steam engines, which are intended to be used as a reserve. The fifth motor is coupled to a tractive generator, of the Thury type, which produces 400 horse power at 600 volts.

A second tractive generator of the Thury type and a storage battery with a Thury booster complete the equipment. It is worth remarking that, for its experiments upon the insulation of the line from St. Maurice to Lausanne, the Compagnie de l'Industrie Electrique of Geneva has constructed a dynamo which is capable of a current of one ampere under a tension of 25,000 volts. Enormous progress is here evinced, since up to the present the highest tension obtained for a simple direct current was 10,000 volts and that with difficulty. It is also a fine showing to have doubled by more than half, the admissible tensions, and do it at one stroke, too.

The services which this machine is capable of rendering and has already rendered are very considerable. While testing out the high-tension line from St. Maurice to Lausanne, this machine was of inestimable assistance in discovering leaks caused by the branches of the trees coming in contact with the wire, losses so small that the galvanometer did not register them. Moreover, it has been employed in testing high-tension cables. It affords also an opportunity for many very curious and interesting experiments upon the combination of gases under the influence of the electric arc at high tension, such as, for instance, the combination of azote (nitrogen) and oxygen in the manufacture of nitric acid. In fine, scarcely a day passes but it is employed in many experiments which it would be impossible to make without its valuable aid. We are

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

loath to close this article without adding a few words upon a most decisive experiment effected upon this line from St. Maurice to Lausanne, the result of which is destined to play an important part in all future installations of this kind. As a matter of fact the transmission of electrical power is not only interesting because of the industrial and financial success of a system which only a very few years ago was considered highly impracticable; certain experiments have been made and results obtained from them which are of considerable scientific and technical value; such, for example, as the experiments leading to the use of the earth as a conductor for high-tension currents, which have been crowned with brilliant success, the more

FIG. 4.—SHORT-CIRCUITING SWITCH FOR DYNAMOS FORMING ONE OF THE UNITS AT ST. MAURICE.

remarkable since the perturbations which might have resulted from it upon the telegraphic and telephonic circuits are absolutely nil, for the Thury system maintained a constant or invariable intensity. Two conductors, the cross sections of which measure 150 millimeters each, compose the line wires from St. Maurice to Lausanne. The total resistance of the line is 13.3 ohms at 20 deg. C., and the normal loss is 2,000 volts, say about 9 per cent of the energy at the disposal of the generating station. The wire weighs about 152 tons, or about 30 kilogrammes (66 pounds) per horse power.

The problem here presented was the reduction of the line to a single conducting wire, the return to be sent through the earth itself. Now if the earth did not offer any resistance, the losses in the wire resistance, together with the weight of copper used, might thus be reduced just one-half, to about, say, 15 kilogrammes of copper wire per horse power, and a 4½ per cent loss under full load; or, perhaps more clearly stated, with the same percentage of loss as was had with the regular return-wire system, viz., 9 per cent, the amount of copper in the single transmitting wire could be reduced to about one-quarter of the former amount, say about 7½ kilogrammes per horse power, an extremely low figure for 56 kilometers of transmission line. However, in practice the results did not turn out quite so favorably. But with a single line, returning through the earth, that is with 15 kilogrammes of wire instead of 30 kilogrammes per horse power, the total loss was 1,210 volts, or about 5 3-10 per cent. The gain upon the ordinary transmission, such as was in actual use was, however, on the one hand, great economy in the consumption of copper, only 56 tons being required, and, on the other, a marked saving in energy, which was equal to 700 volts multiplied by 150 amperes or 118,500 watts, which is a result in every way encouraging. The earth's total resistance amounted to exactly 1.4 ohms, entirely attributable to faulty contact between the grounding plates and the soil, as well as to the inherent resistance of the latter in the immediate neighborhood of the points of insertion of the grounders. Properly speaking, the distance between the stations counts for absolutely nothing, in this resistance, and one may safely maintain that had the two points of contact with the earth been placed at the antipodes instead of only 56 kilometers apart, the results would have been precisely the same.

MORTAR.

LIKE all other compounds, mortar depends for its quality upon that of its constituents, and also upon the proportions in which they are used, and the method by which they are mixed. To all intents and purposes, it is an exceedingly fine concrete, composed of an aggregate and a matrix mixed with water, its purpose being to fill up the interstices in the joints between the bricks or stones of which a wall is composed, so as to provide an even bedding surface, and render the wall watertight, its adherent properties being rather more valuable for securing this, than needed to prevent the bricks from being pulled apart.

Thus it comes about that the more close is the jointing of a wall, the finer should be the grain of the mortar, and of its aggregate. A coarse rubble wall having wide irregular mortar joints would be best with a mortar made of a fine gravel or crushed stone, or, at least, with one which contained a considerable amount of pea-sized lumps as well as finer sand among the aggregate, to assist in filling up the larger hollows without undue liability to settlement. On the other hand, for well-dressed ashlar masonry, the finest sharp-grained sand obtainable should be used, there being only very small cavities to fill up, and the very thinnest possible joint being required.

Beyond this, it is necessary in all cases that the aggregate should, under a magnifying glass, display either sharp edges or a roughened surface or both, in order that the matrix may adhere to it; for, while there is little necessity to stick the bricks of a wall together, if they be properly laid, it is quite necessary that the mortar should form in itself a homogeneous substance, else it will crumble into dust or wash out of the joints. Chippings of a soft stone crushed in a mortar will form an excellent aggregate, when obtainable, especially if sifted to various grades of fineness for different work; and old bricks similarly crushed are even better, as being rougher in texture. Sharp pit-sand is, perhaps, most commonly specified, but it should be really sharp, and not, as is frequently the case, rounded by attrition—in reality, from the bed of an old river, though now dug from a pit. In the same way it should be free from salt, and pit-sand from a prehistoric sea beach is sometimes as salt as that gathered on the existing shore, for salt attracts moisture, and a wall built with salt sand in the mortar will scarcely ever dry.

For the same reason sea water must not be used for

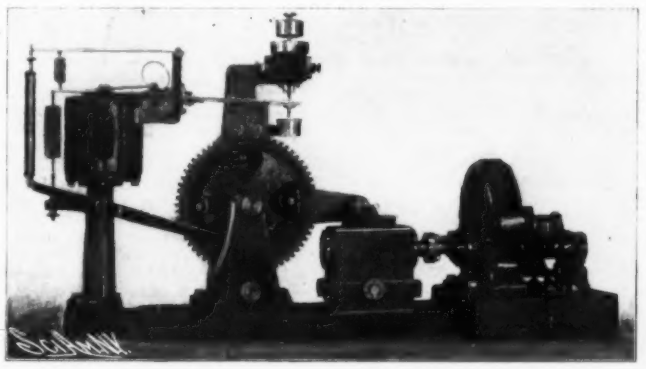


FIG. 5.—VOLTAGE-REGULATOR OF THE ST. MAURICE PLANT.

mixing; but this objection against the use of sea sand and sea water disappears in the case of many boundary and retaining walls, which need not become dry, though the result of their use is frequently an unsightly funguslike efflorescence on the face of the wall.

So far as the matrix is concerned, an ordinary mildly hydraulic ground stone lime is in almost universal use for ordinary building. Pure or poor limes are alike unsuitable, having no setting property, but merely drying, and being consequently easily washed away by rain; and, although some prefer to reduce their lime to powder by slaking, it is much better to buy it ready-ground and to mix the sand with the hot lime day by day as it is required, the usual proportion being about three measures of sand to each measure of lime.

Many architects specify 2½ measures of sand per measure of lime for good work, but it is doubtful whether the resulting mortar is greatly improved. On the other hand, if plaster of paris be mixed with the lime, a greater proportion of sand can be carried without loss of strength, though it is hardly worth doing, owing to the extra cost of the plaster and to its solubility.

If a stronger mortar be required, as in very thin partition walls, or in weight-carrying piers, Lius lime should take the place of the ground stone lime, or else Portland cement should be used. With cement as the matrix the proportion of sand may be raised to as much as 6 to 1 in almost all cases. Cement mortar must only be mixed as required, a little at a time, else it will commence to set before it is finally worked up with the trowel before use, and if this occurs, its strength becomes greatly impaired.

Coloring substances ought not to be mixed with mortar, particularly if they are of an earthy nature, like the umbers and ochers, but a dark mortar, very suitable for the facing of red brickwork, can be made by using blacksmith's ashes or foundry sand in place of ordinary yellow sand.

Lime mortar is best mixed in a mortar mill, the sand and lime being shoveled in as it revolves, three spadefuls of one to one spadeful of the other, only just enough water being added to bring the whole to the consistency of porridge; but cement mortar, having to be made in small quantities, must be mixed by hand. Like cement concrete, it should be mixed dry, the water added through the rose of a watering pot, and then mixed again with wet.—G. A. T. Middleton in the Irish Builder.

HOW TO EMBELLISH CHEAP FURNITURE.

To every professional cabinetmaker the problem has doubtless been already presented of making cheap furniture, which, in spite of the lowest price, should present to the eye a pleasing appearance. Carving or tarsia (inlaid) work cannot, of course, be thought of in this connection, as these would materially raise the price of the furniture. The following procedure will, accordingly, enable the joiner to decorate the furniture in a beautiful and appropriate way without the necessity of enlisting therefor the aid of other professional artisans.

Every joiner is expected to have had some practice in drawing and to be capable, therefore, of getting up designs for the decoration of panels, front-pieces of drawers, etc. This drawing he has, accordingly, to transfer by means of tracing-paper upon the portions of wood to be decorated and to fill the ornament or the ground, according to the effect intended, with gum arabic. The gum must not be too weak in order that it may properly cover the parts smeared, and must also be entirely colorless, for otherwise the wood becomes stained. Then, after having allowed the parts to dry for a day, the panels, etc., should be rubbed by means of a woolen rag vigorously, though sparingly, with printers' ink previously diluted with a little petroleum, so that the wood may receive a uniform coloring. This ink can be obtained in all shades and one may therefore choose the tint which shall harmonize with the given stain of the wood. The whole must then be wiped off with a sponge, whereby the gum is dissolved and the parts that were covered remain standing out with distinctness. The gum must of course be entirely washed

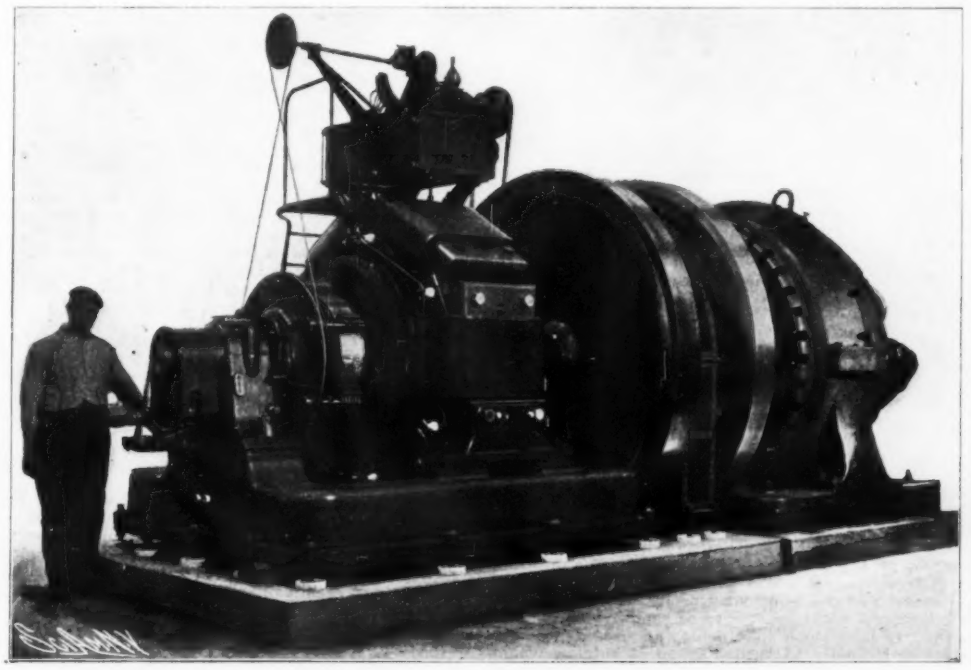


FIG. 6.—SERIES-WOUND MOTOR OF 400 HORSE POWER COUPLED TO A THREE-PHASE, 3,000-VOLT, ALTERNATOR

off and particular care should be given to this point.

If the ground has been rubbed in, the ornament being in that case left untouched, then it becomes an easy matter to color the same with ordinary water-stain, inasmuch as the printer's ink, by reason of its fatty contents, does not take any water staining. The furniture is now treated as usual—either waxed or polished; whereby the fatty nature of the ink renders very good service.

For such manner of ornamentation only light woods are, of course, adapted, such as fir, pine, ash, maple, oak, etc.; while walnut or mahogany, on account of their dearness, do not even come into consideration for simple furniture. By the designing of the ornament much depends upon a proper distribution of the same. Very poor and monotonous would be the effect of filling the given surface with it completely. It is just in limitation and the happy selection of the place where the ornament is suited that one shows himself a master. Above all will those places have to be decorated which first catch the eye, or are especially conspicuous because of their monotonous lines. In case of a door which, perhaps through a desire of saving a framing piece, has been given a very long panel, it will be commendable to set off the upper quarter of the same by means of an ornament. The bounding lines of the latter need not, however, run exactly parallel to the framing of the panel, but a somewhat greater freedom of form may be allowed here.

It is likewise of great importance to consider that one and the same ornament has a different effect according as to whether the ground is executed in dark and the ornament light, or *vice versa*. The light ornament (with dark ground) will always have a larger and fuller effect than the dark ornament on a light ground; and this must in the designing be taken into consideration.—Der Stein der Weisen.

[Continued from SUPPLEMENT No. 1442, page 23106.]

TOTEMISM.*

By A. C. HADDON, M.A., Sc.D., F.R.S., M.R.I.A.

A SUGGESTION CONCERNING THE ORIGIN OF TOTEMISM.

I take this opportunity to hazard a suggestion for a possible origin of one aspect of totemism. Primitive human groups, judging from analogy, could never have been large, and the individuals comprising each group must have been closely related. In favorable areas each group would have a tendency to occupy a restricted range owing to the disagreeable results which arose from encroaching on the territory over which another group wandered. Thus it would inevitably come about that a certain animal or plant, or group of animals or plants, would be more abundant in the territory of one group than in that of another. To take a clear example, the shore-folk and the river-folk would live mainly on different food from each other and both would have other specialties than fell to the lot of the jungle-folk. The groups that lived on the seashore would doubtless have some natural vegetable products to supplement their animal diet, but the supply would probably be limited alike in quantity and variety. Even they would scarcely have unlimited range of a shore line, and there would be one group of shore-folk that had a specialty in crabs, another would have shell-beds, while a third would own sandy shores which were frequented by turtle. A similar natural grouping would occur among the jungle-folk; sago flourishes in swampy land, certain animals frequent grassy plains, others inhabit the dense scrub, bamboos grow in one locality, various kinds of fruit trees thrive best in different soils; the coastal plains, the foot hills, the mountains, each has its characteristic flora and fauna. There is thus no difficulty in accounting for numerous small human groups each of which would be largely dependent upon a distinctive food supply the superfluity of which could be bartered† for the superfluities of other groups. These specialties were not confined to food alone; for example, the shore-folk would exchange the shells they collected for the feathers obtained from the jungle-folk.

It may be objected that in the great prairies and steppes of America, Eurasia and Australia the natural products are very uniform; but these areas are not thickly populated, and in most cases they probably were only inhabited when the pressure of population in the localities with more varied features forced migration into the open. Certainly these never were the primitive homes of man.

In a recent paper read before the Folklore Society, Mr. Andrew Lang put forward the hypothesis that while each primitive human group called itself "the men," they named the surrounding groups from the names of animals or plants, and hence arose totemism. The idea that there was an intimate connection between the group and the object from which they were nicknamed would soon be developed, and myths of origin would spring up to account for the name. Mr. Lang's theory, still unpublished, regards totem names as given from without for a variety of reasons, among which, I understand, he includes my own suggestion. His conjecture is based on the similar names, or sobriquets, of villages in the folklore, or *blason populaire*, of France and England, which, again, is almost identical with the extant names of Red Indian totem kindred now counting descent in the male line. Similar phenomena occur in Melanesia with female kin. Mr. Lang is rather indifferent to the causes of the name-giving so long as the name-giving comes from without and applies to groups, not to individuals.

To return to my suggestion. Among the shore-folk the group that lived mainly on crabs and occasionally traded in crabs might well be spoken of as the "crab-men" by all the groups with whom they came in direct or indirect contact. The same would hold good for the group that dealt in clams or in turtle, and reciprocally there might be sago-men, bamboo-men, and so forth. It is obvious that men who persistently collected or hunted a particular group of animals would understand the habits of those animals better than other people, and a personal regard for these animals would naturally arise. Thus from the very beginning there would be a distinct relationship between a group of individuals and a group of animals or plants, a relationship that primitively was based, not on even the most elementary of psychic concepts, but on the most deeply seated and urgent of human claims, hunger.

There is scarcely any need to point out that the association of human groups with fearsome animals would arise by analogy very early. Hence tiger-men and crocodile-men would restrain the ravages of those beasts (Dr. Frazer, Fortnightly Review, 1899, p. 835, describes this as the negative or remedial side of totemic magic); but I take it this was not as primitive as the nutritive alliances. The relation between groups of men and the elements has a purely economic basis; for example, rain is rarely required for itself, but as a means for the increase of vegetable food; similarly the fisherman wants a wind to enable him to get to and from his fishing grounds.

The next phase is reached when man arrived at elementary metaphysical conceptions and endeavored by sympathetic or symbolic magic to increase his food supply. Naturally the food or product that each group would endeavor to multiply would be the specialty or specialties of that group, and for this practice we now have demonstrative evidence. Though this may be an early phase of totemism, I do not consider it the earliest; it can scarcely be the origin of totemism, but it doubtless helped to establish and organize the system.

The essential difference between the view advocated by Dr. Frazer (*loc. cit.*, 1899, p. 835), and that here suggested is that according to him totemism "is primarily an organized and co-operative system of magic designed to secure for the members of the community, on the one hand, a plentiful supply of all the commodities of which they stand in need, and, on the other hand, immunity from all the perils and dangers to which man is exposed in his struggle with nature. Each totem group, on this theory, was charged with the superintendence and control of some department of nature from which it took its name, and with which it sought, as far as possible, to identify itself." Whereas I suggest that the association between a group of men and a species of animals or plants was the natural result of local causes, and that departments of nature were not "assigned to a particular group" of men. I think it is scarcely probable "that in very ancient times communities of men should have organized themselves more or less deliberately for the purpose of attaining objects so natural by means that seemed to them so simple and easy." I suspect that if there was any deliberate organization it was in order to regulate already existing practices.

To us it might appear that these magical practices could be undertaken by any one, but this does not seem to have been an early conception. As far as we can penetrate the mind of existing backward man, there is a definite acknowledgment of the limit of his own powers. The members of one group can perform a certain number of actions; there are others that they cannot undertake. One group of men, for example, may insure the abundance of a certain kind of animal, but another will have power over the rain. An interesting example of this limitation is afforded at Port Moresby, in British New Guinea, where the Motu immigrants have to buy fine weather for their trading voyages from the sorcerers of the indigenous agricultural Koitapu (J. Chalmers, "Pioneering in New Guinea," 1887, p. 14).

The remarkable researches of Messrs. Spencer and Gillen in Central Australia prove that it is the function of the kinsmen of a particular totem to perform what are known as *intichiuma* ceremonies, the object of which is to cause the abundance of the species of animal or plant which is the totem of that kin. The descriptions of these ceremonies are well known to students.* I have adduced further evidence of a like nature;† and from what Mr. Roscoe has found in Uganda we may expect other examples from Africa.

It may be that in some, possibly in all, of the instances of sympathetic and symbolic magic there is a belief that wind or sun, animal or plant, or whatever the objects may be, are animated by spirits akin to those of humankind; but even so, as Dr. Frazer‡ points out, the action of the magician is a direct one; it does not imply the assistance of other powers who can control the body or spirit of those objects. The data from Australia and Torres Straits point to the conclusion that there is a magical aspect of totemism, which is of great economic importance, and there is no evidence that the officiators at these ceremonies acknowledge the assistance of spiritual powers resident either within the objects themselves or in the form of independent, more or less supreme beings. The existing data do not deny their existence, they simply ignore them in the ceremonies, and so far they are practically non-existent.

According to the suggestion I have ventured to make, the primitive totemic groups ate their associated animals or plants; indeed, these were their chief articles of diet. Messrs. Spencer and Gillen point out§ that while among most Australian tribes a man may not eat his totem, among the Arunta and other tribes in the center of the continent there is no restriction according to which a man is altogether forbidden to eat his totem. On the other hand, though he may only, under ordinary circumstances, eat very sparingly of it, there are certain special occasions on which he is obliged by custom to eat a small portion of it, or otherwise the supply would fail. The Arunta are a peculiar people, while they may be primitive in some respects; in others they are not so, as also has been pointed out by Durkheim ("L'Année Sociologique," v. 902). According to the strict definition of the term, they are not even a totemic people. Judging from the evidence of the legends of the Alcheringa time and the traces of group marriage and mother right, Mr. Hartland ("Folk-lore," xi. 1900, pp. 73-75) is of opinion that the present disregard by the Arunta of the totem in marriage is a stage in the sloughing of totemism altogether, whereas the *engwura*, or final initiation ceremonies, indicate that "the organization is undergoing a slow transformation into something more like the so-called secret societies of the British Columbian tribes."

The eating of what are evidently the totem animals by the Arunta may possibly be a persistence from an earlier phase, but, without doubt, the totem taboo is characteristic of totemism in full sway.* We have evidence to show that under certain conditions the totem taboo may break down, but this is a later transformation, and indicates a breaking up of the rigid observance of totemism.

Mr. Lang ("Magic and Religion," 1901, pp. 264, 265) has made a simple suggestion to account for the origin of the totem taboo. He says: "These men therefore would work the magic for propagating their kindred in the animal and vegetable world. But the existence of this connection would also suggest that, in common decency, a man should not kill and eat his animal or vegetable relations. In most parts of the world he abstains from this uncousinly behavior; among the Arunta he may eat sparingly of his totem, and must do so at the end of the close-time or beginning of the season. He thus, as a near relation of the actual kangaroo or grubs, declares the season is open, now his neighbors may begin to eat grubs or kangaroos; the taboo is off." Dr. Frazer puts forth two suggestions (Fortnightly Review, 1899, pp. 838-40): the one is that as animals do not eat their own kind, so man thought it inconsistent to eat his totem kin; the other is a hypothetical idea of conciliation.

I have barely touched upon the relation of social organization, with its marriage taboo, to totemism. It is by no means certain that the social regulations and customs, which are so much in evidence in a fully developed totemic society, were primitively connected with totemism. So far as the Arunta are concerned, Messrs. Spencer and Gillen believe (Journ. Anthrop. Inst., xxviii. 1899, pp. 277, 278) the "totemism appears to be a primary, and exogamy a secondary feature . . . and that exogamic groups were deliberately introduced so as to regulate marital relations." But is this primitive?

If one admits that mankind was originally distributed in small groups, which must have consisted of near kin, it does not seem difficult to imagine that marriage would more likely take place between members of contiguous groups rather than within the groups themselves. The attraction for novelty must always have operated, and in the struggle for existence there was always one advantage to be gained by alliances between neighboring groups, not only from a commissariat point of view, but for offensive and defensive purposes. There is, of course, the converse of this, as wife-stealing would lead to feuds; perhaps daughter-abduction was more frequent, and this probably was not regarded as an offense so serious that a mild scrimmage would not set matters right. It would not take long for wont to crystallize into rigid custom, and custom is always supported by public opinion.

Social regulations must be later than social conditions, and I suspect that the privileges and taboos which run through the social aspect of totemism first arose when totemic groups were in process of aggregation into more complex communities, and afterward gradually became fixed into a system.

HERO-CULTS.

The facts to which I have hitherto directed your attention fall well within the sphere of totemism, but I wish now to indicate two interesting departures from typical totemism, both of which occur among the Western tribe of Torres Straits.

I have alluded to the dual grouping of the totem kins at Mabuiag, and an analogous arrangement occurred in the other islands; I propose to speak of each group of kins as a phratry. Strictly speaking, a phratry is a group of exogamous kins within a community; that is, no member of a group of kins (or phratry) could marry another person belonging to the same phratry. The evidence that this is or was the case in the Western tribe of Torres Straits is strong, but it is not absolutely proven.

In Yam, as in the other islands, there is at least one *kwod*, or taboo ground, where sacred ceremonies were held. In the principal *kwod* in Yam there was formerly a low fence surrounding a space of about thirty-five square feet in which were the shrines of the two great totems of the island. All that now remains is several heaps of great Fusus shells.

Two of the heaps are about twenty-five feet in length. Formerly at the southerly end of each long row of shells was a large turtle-shell (tortoise-shell) mask representing respectively a crocodile and a hammer-headed shark. These were decorated in various ways, and under each was a stone in which the life of the totem resided; stretching from the front end of each mask was a cord to which numerous human lower jaw-bones were fastened, and its other end was attached to a human skull, which rested on a stone. Beside the shrine of the hammer-headed shark was a small heap of shells which was the shrine of a sea-snake, which was supposed to have originated from the shark. These shrines were formerly covered over by long low huts, which like the fence were decorated with large Fusus shells.

Outside the fence were two heaps of shells which had a mystical connection with the shrine; they were called the "navels of the totems."

I have referred to the *intichiuma* ceremonies of the Arunta tribe of Central Australia as being magical rites undertaken by certain kinsmen for the multiplication of the totems. In some cases, apparently, the ceremonies may take place wherever the men happen to be camping; in other cases there are definite localities where they must be performed, as there are in these places certain stones, rocks, or trees which are intimately connected with the magical rites. These spots may be spoken of as shrines. In the island of Mabuiag the magical ceremony for the alluring of the dugong was performed by the men of that kin in their own *kwod*, which was a fixed spot; and doubtless this was the case in the other islands of Torres Straits, for even in the small islands there was a tendency to a territorial grouping of the kins. This localization of a totem cult has proceeded one step further in Yam Island. Here we have a dual synthesis. The chief totem of each group of kins is practically alone

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* Address before the British Association for the Advancement of Science.

† It may be objected that the idea of barter is by no means primitive; but as I believe that sociability was a fundamental characteristic of primitive man I can see no reason why it should not have occurred quite early in a rudimentary sort of way.

* Baldwin Spencer and F. J. Gillen, "The Native Tribes of Central Australia," 1899; cf. also J. G. Frazer, Fortnightly Review, 1899, pp. 648, 835.

† "Folk-lore," xii. 1901, p. 230, and "Report Camb. Anthrop. Expedition to Torres Straits," vol. v. (in the press).

‡ *Loc. cit.*, 1899, p. 657.

§ *Loc. cit.*, pp. 73, 167.

* I am fully aware that this appears to cut the ground from under my suggestion; but the latter deals with incipient totemism, and I do not see why the totem taboo should not have arisen from several causes.

recognized; in other words, the various lesser totems are being absorbed by two more important totems. Each totem has a distinct shrine, and the totem itself, instead of being a whole species, is visualized in the form of a representation of an individual animal, and this image was spoken of as the totem (*augud*). Indeed, the tendency to concretism had gone so far that the life of the *augud* was supposed to reside in the stone that lay beneath the image,* and certain heaps of shells were the navels of the totems, a further linkage of the totem to that spot of ground.

A suggestion as to the significance of this transformation is not lacking. There are various folk-tales concerning a family of brothers who wandered from west to east across Torres Straits. Some of them were, in a mysterious way, sharks as well as men. The two brothers who went to Yam were called Sigai and Maiau, and each became associated, in his animal form, with one of the two phratries. The shrines in the *kwod* were so sacred that no women might visit them, nor did the women know what the totems were like. They were aware of Sigai and Maiau, but they did not know that the former was the hammer-headed shark and the latter was the crocodile; this mystery was too sacred to be imparted to the uninitiated. When the totems were addressed it was always by their hero names, and not by their animal or totem names.

Malu, another of these brothers, introduced the cult that bears his name to the Murray Islanders, who form part of the Eastern tribe. He also was identified with a hammer-headed shark. Totemism, as such, had practically disappeared from Murray Island before the advent of the white man, and the great ceremonies at the initiation of the lads into the Malu fraternity were a main feature of the religion of these people.

In Yam totemism was merging into a hero cult; in Murray Island the transformation was accomplished; the one had replaced the other.

In Mabuiag, one of the Western Islands, there was a local hero named Kwoiam whose deeds are narrated in a prose epic. Kwoiam made two crescentic ornaments of turtle-shell, which blazed with light when he wore them at night-time, and which he nourished with the savor of cooked fish. These ornaments were called totems (*augud*)—presumably because the natives did not know by what other sacred name to call them—and they became the insignia of the two groups of kins of Mabuiag. The crescent which was worn above Kwoiam's mouth was regarded as the more important, and those kins which had land animals for their totems were called from it "the children of the great totem," but the water group was called "the children of the little totem." There is reason to believe that the dual grouping of the kins is ancient. The erecting Kwoiam's emblems as the head totems of the two groups of kins must be comparatively recent. Here, again, the primitive association of a group of men with a group of natural objects obtains in the small groups of totem kins, but in the larger synthesis a manufactured object replaces a group of animals, and this object possesses definite magical powers. There were two navel-shrines connected with the cult of Kwoiam, which were constructed to show that the two *augud* were born there. When it was deemed necessary to fortify the *augud*—that is, the emblems—they were placed on their respective navel-shrines. Further, in Muralug and the adjacent islands Kwoiam himself was a totem (*augud*). Thus in the westernmost islands of the Western tribe the transition from totemism to hero-worship was in process of evolution till it was arrested by the coming of the white man.

To what was this transformation due? It is not very easy to answer this question. We have evidence that in comparatively recent times a change took place in the social organization of the people, and that the former matriarchal conditions had been replaced by patriarchal. Although superficially the marriage system of the Western tribe appears to be regulated by totemism, Dr. Rivers has found† that it is really a relationship system, and that descent, rather than totemism, is the regulating factor. The Eastern tribe, as represented by the Murray Islanders, had progressed further along this road than had the Western tribe. Such a change as this could not fail to have a disturbing effect upon other old customs.

The folk-tales that I collected clearly indicate a migration of culture from New Guinea to the Western tribe, and from the Western tribe to the Eastern tribe. I believe I can demonstrate the migration from New Guinea of a somewhat broad-headed people that spread over the Western Islands but barely reached Murray Island. It is conceivable that the culture myths have reference to this migration, and that the gradual substitution of a hero cult for totemism may be part of the same movement; but, on the other hand, this social and religious change is most thorough in Murray Island, where, I imagine, the racial movement has been least felt. The isolation of Murray Island from outside disturbing factors is very complete, and, being but a small island, a change once started might take place both rapidly and effectively.

It is interesting to note that the totem heroes of the Western tribe were invoked when their votaries were preparing to go to war. I obtained the following prayer in Yam Island: "O *Augud* Sigai and O *Augud* Maiau, both of you close the eyes of those men so that they cannot see us," which had for its intent the slaughtering of the enemy without their being able to make a defense. I was informed that when the Yam warriors were fighting they would also call on the name of Kwoiam, who belonged to another group of islands, and on Yadzebub, a local warrior. Yadzebub was always described as a "man," whereas Kwoiam and Sigai were relegated to a "long time" back. From the folk-tales it is evident that Sigai and Maiau are more mythical or mysterious than Kwoiam. We thus have an instructive series: Yadzebub, the local famous man; Kwoiam, the hero, who was also a totem to other people; and Sigai and Maiau, the local totem heroes whose cult was visualized in turtle-shell images, and the life of each of whom resided in a particular stone. Perhaps it would be more correct to speak of this as the grafting of a new cult on totemism rather than to describe it as an evolution of totemism. A transformation has certainly occurred, but it does not appear to me to be a gradual growth—a metamorphosis in the natural-history sense of the term—so much as the pouring of new wine into old bottles.

I hope on another occasion to deal with the question of religious and secret societies, as the growth of these has invariably disintegrated whatever antecedent totemism there may have been.

It is highly probable that something like what was taking place in Torres Straits has occurred elsewhere, but I cannot now enter into a comparative study of the rise of hero cults.

LOCAL OR VILLAGE EXOGAMY.

I have more than once ("Folk-lore," xii. 1901, p. 233; "Headhunters, Black, White, and Brown," 1901, p. 258) called attention to the fact that among some Papuans marriage restrictions are territorial and not totemic. Dr. Rivers (Journ. Anthrop. Inst., xxx. 1900, p. 78) has shown that in Murray Island, Eastern tribe of Torres Straits, marriages are regulated by the places to which natives belong. A man cannot marry a woman of his own village or of certain other villages. The totemic system which probably at one time existed in this island appears to have been replaced by what may be called a territorial system. A similar custom occurs in the Mekeo district of British New Guinea, and it is probably still more widely distributed.

I was informed by a member of the Yaraikanna tribe of Cape York, North Queensland, that children must take the "land" or "country" of their mother; all who belong to the same place are brothers and sisters, a wife must be taken from another "country" ("Brit. Assoc. Report," Dover, 1899, p. 585); thus it appears their marriage restrictions are territorial and not totemic. The same is found among the Kurnai and the Coast Murring tribe in New South Wales (Frazer, "Totemism," p. 90).

At Kiwai, in the delta of the Fly River, B. N. G., all the members of a totemic group live together in a long house which is confined to that group. I have also collected evidence which proves there was a territorial grouping of totemic clans among the Western tribe of Torres Straits ("Reports Camb. Anthrop. Expedition to Torres Straits," v. in the press).

Within a comparatively small area we have the following conditions:

(1) A typical totemic community with totem-kin houses (Kiwai).

(2) A typical totemic community with territorial grouping of the kins. Although there is totem exogamy, the marriage restrictions are regulated by relationship. The former mother-right has comparatively recently been replaced by father-right, but there are many survivals from matriarchy (Western tribe, Torres Straits).

(3) A community in which totemism has practically lapsed, with village exogamy and marriage restrictions regulated by relationship, patriarchy with survivals from matriarchy (Eastern tribe, Torres Straits).

(4) Total absence of totemism (?), village exogamy (Mekeo).

I do not assert this is a natural sequence, but it looks like one, and it appears to indicate another of the ways out of totemism. It is suggestive that this order also indicates the application of the several peoples to agriculture; the people of Kiwai are seminomadic, those of the Mekeo district are firmly attached to the land. This constraint of the soil must have operated in a similar manner elsewhere (cf. "L'Année Sociologique," v. 1902, pp. 330, 333). The territorial exogamy occasionaly found in Australia cannot be explained as being due to agriculture; a rigid limitation of hunting grounds may here have had a similar effect.

In offering these remarks to-day I desire, above all, to impress on you the need there is for more work in the field. When one surveys the fairly extensive literature of totemism one is struck with the very general insufficiency of the evidence; as a matter of fact, full and precise information is lamentably lacking. The foundations upon which students at home have to build their superstructures of generalization and theory are usually of too slight a character to support these erections with much chance of their permanence. There is only one remedy for this, and that is more extensive and more thorough field work. The problems connected with totemism bear upon many of the most important phases in the social and religious evolution of man, the solution of which can only be obtained within the space of a few years. The delay of each year in the investigation of primitive peoples means that so much less information is possible to be obtained. There is no exaggeration in this. Those who have practical experience of backward man and who have traveled in out-of-the-way places can testify as to the surprising rapidity with which the old order changeth. In sober earnestness I appeal to all those who are interested in the history and character of man, whether they be theologians, historians, sociologists, psychologists, or anthropologists, to face the plain fact that the only available data for the solution of many problems of the highest interest are daily slipping away beyond recovery.

* For the keeping of a soul in an external receptacle, and for Dr. Frazer's views on its bearing on totemism, cf. Fortnightly Review, May, 1890, p. 841; "The Golden Bough," iii. 1900, pp. 418-422; and S. A. Cook, Jewish Quart. Review, 1902, p. 34 of reprint.

† "Reports Camb. Anthrop. Expedition to Torres Straits," v. "Kinship" (in the press).

THE PRODUCTION OF A BLACK COLOR ON BRASS.

By ERWIN S. SPERRY.

MUCH difficulty is often experienced by platers and other brass workers in the production of a satisfactory black color on brass. This would, perhaps, appear somewhat ridiculous inasmuch as brass will of its own accord oxidize to a black color if left for any length of time. Oxidized silver, which was much in vogue at one time, greatly stimulated the production of a similar finish on brass, and the same method was employed, but usually with unsatisfactory results. In the oxidation of silver the property of tarnishing by sulphur compounds is made use of, as the ready susceptibility of this metal to such influences is sufficient to render the process quite satisfactory. Silver is very easily blackened by sulphur and its compounds, and all that is necessary to do is to bring it in contract with a solution of potassium or sodium sulphide (liver of sulphur), when an immediate blackening takes place. The same method used on brass produces a black color, but not entirely satisfactory, as it is wanting both in color and in depth. If allowed to remain for a long time, in order to obtain a deep black, the coating does not appear to adhere, but scales off. These difficulties render the employment of sulphur compounds in blackening brass more or less unsatisfactory, and much trouble is found in their use. Those who have attempted their use have usually abandoned the method in favor of others.

The solution now generally employed for the production of a black or oxidized surface on brass is a solution of carbonate of copper in ammonia. The work is immersed in it and allowed to remain until the required tint is produced. The carbonate of copper is best used in the so-called plastic condition, as it is then much more easily dissolved. Plastic carbonate of copper may be purchased, but if one wishes to make it, the following method answers well: Make a solution of blue vitriol (sulphate of copper) in hot water, and add a strong solution of common washing soda to it as long as any precipitate forms. The precipitate is allowed to settle and the clear liquid is poured off. Hot water is now added, and the mass stirred and again allowed to settle. Again the clear liquid is poured off, and the operation of adding water, settling, and pouring off repeated. This is continued until everything has been washed out of the green carbonate of copper, which remains in the bottom of the vessel. Six or eight times is usually sufficient to remove the impurities. After the water has been removed during the last pouring and nothing is left but an emulsion of the thick plastic carbonate in a small quantity of water, liquid ammonia is added until everything is dissolved and a clear, deep-blue liquid is produced. If too strong, water may be added, but I have found that a strong solution works better than a weak one. If it is desired to make the solution from commercial plastic carbonate of copper, the following directions may be followed: Dissolve one pound of the plastic carbonate of copper in two gallons of strong ammonia. This gives the required strength of solution.

The brass which it is desired to blacken is first boiled in a strong potash solution to remove grease and oil, then well rinsed and dipped in the copper solution, which has previously been heated to from 150 to 175 deg. F. This solution does not work well cold, and if heated too hot gives off all the ammonia. The brass is left in the solution until the required tint is produced. The color produced is very uniform and black. It also holds tenaciously and does not readily peel off. After the desired color is produced, the brass is rinsed and dried in sawdust. A great variety of effects may be produced by first finishing the brass before blackening, as the oxidizing process does not injure the texture of the metal at all. A very satisfactory finish is produced by first rendering the surface of the brass matt, either by scratch brush or similar methods, as the black finish thus produced by the copper solution is then dead—one of the most pleasing effects of an oxidized surface. Various effects may also be produced by coloring the entire article and then buffing off the exposed portions.

The best results in the use of this solution are obtained by the use of the so-called red metals—i.e., those in which the copper predominates. The reason for this is quite obvious. Ordinary sheet brass consists of about two parts of copper and one part of zinc, so that the large quantity of the latter somewhat hinders the production of a deep black surface. Yellow brass is colored black by means of the solution, but if the very best results are desired, it is well to use some metal having a reddish tint, indicating the presence of a large amount of copper. The varieties of sheet brass known as gilding or bronze work well. Copper also gives excellent results. Where the best results are desired on yellow brass a very light electro-plate of copper before the oxidizing works well and gives an excellent black. With the usual articles made of yellow brass, however, this is rarely done, but the oxidation carried out directly.—Metal Industry.

CHANGES IN JAPANESE CHARACTER WRITING.

THE London Times recently had this to say about certain changes in Japanese character writing: To render a paragraph of French or Latin into English will be found an infinitely simpler business than to change ideograph writing, wherein a whole thought may be represented in a single character, or the ordinary writing, in which one "letter" may stand for a word, into Roman characters. To familiarize the ordinary run of men and women with the Roman method it will certainly be at first necessary to follow the plan proposed by the department, and begin the instruction in higher primary, if not in primary, schools. The scheme, if adopted, will probably come into operation at the beginning of the next scholastic year, leaving a few months for the preparation of the readers and other handbooks. The possibility of the government setting aside the expert advice is remote, and therefore it is permissible to contemplate the suggestion as something by no means chimerical.

When accomplished, the Romanization of the Japanese language will put the final touch of victory to that revolution begun some forty years ago. It is difficult to realize in a small measure what the step means to the Japanese nation. Not only will commercial relations be infinitely simplified; not only will ready intercourse between native and European be made a thousandfold easier and thus contribute to the adjustment of political difficulties; not only will the germs of western literature on the one hand and the classics of Japan on the other be rendered accessible to the ordinary translator, but the whole wealth and weight of European thought, opinion, and current criticism will become susceptible of reduction to a common medium, for the mere language of Japan is fairly easy to acquire. The great obstacle hitherto has been the practical impossibility of reaching the bulk of the people, who, acquainted only with character writing, and not much in contact with western people, are still unable to grasp the European aspect of events; but this sug-

gestion if carried out will remove that obstacle. In fact, the Romanization of the written tongue will mark the advent of Japan's maturity, and to this end its adoption in schools is essential.

[Concluded from Supplement No. 1439, page 23062.]

THE SERPOLLET STEAM AUTOMOBILE.*

V. THE GENERATOR.

The generator of the Serpollet surrey is placed at the rear of the vehicle, as shown in Fig. 1. When disclosed to view by the removal of the cover, *P*, and chimneys, *Q*, it presents the appearance shown in Fig. 2. It is a sheet-iron box containing coils of tubing whose ends are connected one to the other, as shown. Three sides of the case, *C*, *C'*, *C'''*, are formed from a single piece of sheet iron, as shown in Fig. 3; but the casing is double-walled and has the intervening space filled with scraps of asbestos packed in loosely, which form a calorific jacket and check as much as possible the loss of heat by radiation. The outside of the casing is also generally covered with sheet asbestos bound on with steel straps. On its bottom, on the inside, is a flange, *T*, for the lower coil of tubing to rest on; while two horizontal V-shaped brackets (not shown in the figure) support the casing on the chassis of the car.

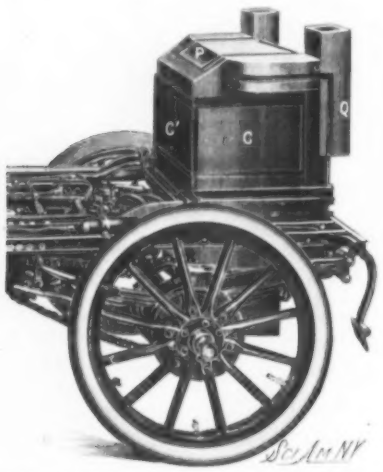


Fig. 1.—GENERATOR IN PLACE ON CHASSIS.

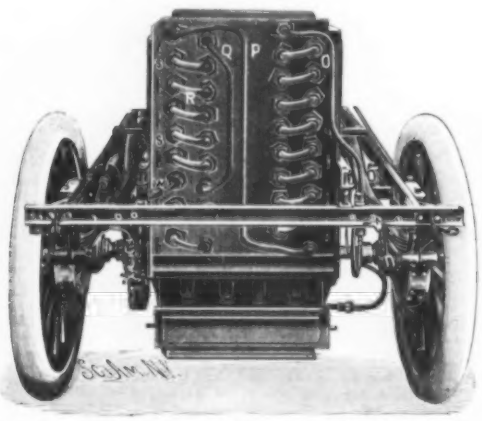


Fig. 2.—GENERATOR WITH CASING REMOVED.

The fourth, or rear side, *C''''*, of the generator casing has four rows of square holes and two rows of smaller, rectangular ones, as shown in Fig. 3. The ends of the generator coils project through the square holes, and the rectangular holes, *mm* receive ears, *nn*, on the sides, *CC'''*, of the casing. Wedges, *ss*, slipped through the ears, hold the side, *C''''*, in place. By withdrawing the wedges, *ss*, and removing the rear side of the casing, the generator tubes are disclosed to view. The coils, or elements, of the generator are composed of soft steel tubing in lengths of about 5.6 meters (18.37 feet), and these lengths are coiled in two layers, the lower forming a serpentine, and the upper, two parallel loops, as shown in Fig. 4. If the pipes were coiled any closer together, they would check the draft of the burner.

The bottom coil of the generator, which rests on the edge, *T*, of the casing, is seen on the left of Fig. 4. This element is called "the frame," and is a simple rectangular coil of soft steel tubing having an inside diameter of 10 millimeters (.393 inch) and an outside diameter of 22 millimeters (.866 inch). Although it might seem otherwise, this element is not the one that receives the greatest heat from the fire, as no part of it is in the center of the firebox. It serves as a support for the other coils, and hence its large outside diameter. The element which rests on this (1, Fig. 4), is the one which is exposed to the full heat of the fire. Consequently the tubing of this element is made of nickel steel, which, although a poor conductor of heat, will not lose its shape or give out in the intense heat. The outside diameter of the tubing of this coil is 20 millimeters (.787 inch), while the inner diameter remains the same as that of the first coil—10 millimeters. The third element from the bottom has the same dimensions, but is made of soft steel, as are also all the other elements. The outside diameter of the tubing of all the other elements is diminished, on account of their being placed farther away from the fire, to 16 millimeters (.629 inch). The smallest inside diameter—that of the fifth to eighth element inclusive—is 9 millimeters (.354 inch), while all the remaining elements have an inner diameter of 12 millimeters (.472 inch).

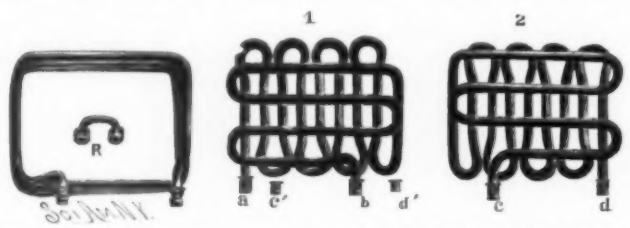


Fig. 4.—THE THREE LOWER COILS OF THE GENERATOR.

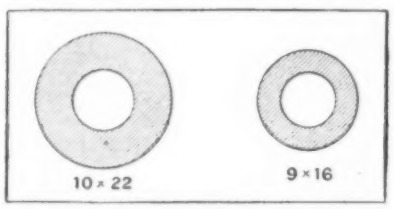


Fig. 5.—ACTUAL SIZE CROSS-SECTION OF TUBING IN SERPOLLET GENERATOR.

The number of elements varies with the power of the motor, in the same manner as do the number of burners employed. The generator of the 12-horsepower light car that we are describing has 18 elements; the 10-horsepower, 15; and the 6-horsepower only 12. It will thus be readily seen that since the tubing of each element is 5.6 meters (18.37 feet) in length, the generator entire consists of a tube over 100 meters (328 feet) in length, made up of 18 sections joined together. The capacity of this tubing is about 14 liters, or, approximately, one-half of a cubic foot.

The joining together of the ends of these 18 elements so as to make an absolutely tight joint is very important. It is accomplished by short C-shaped pipes (*R*, Fig. 4) having unions adapted to screw on the threaded ends of the tubes of the elements. The ends of the tubes have a squared part and shoulder just back of the thread, which keep them from turning and from being drawn through when the union is tightened against the collar *g* (Fig. 6), which is slipped on first.

With regard to the connecting together of the elements, these are not identical, as they might seem from a hasty glance. The ends of the tubing of the element marked 1 (Fig. 4) do not come in the same line as those of element 2. The lower end of the coil of the former, *a*, is on the left, while that of the latter, *d*, is on the right. There are therefore "left" and "right" elements, according to the position of the lower end.

When element 2 is placed above element 1, the end, *c*, does not come directly above the end, *a*, as one might suppose if he did not examine closely; but it comes at *c'*, and *d* at *d'*. Thus, when *a* is connected to *c'* and *b* to *d'*, the connecting pipes will slant, as seen in Fig. 2, and still better in Fig. 7. This explains why the square holes in *C'''* (Fig. 3) are not aligned horizontally as well as vertically.

We now come to the operation of the generator and the circulation of the water and steam through its tubes. Suppose the water enters through the lower coils, i. e., through coil 18 of Fig. 7. The temperature in this coil is very high. The water, therefore, heats quickly, rises in the coils 17, 16, 15, 14, and vaporizes little by little. But, as it rises, the temperature of the elements that it traverses decreases. It vaporizes, therefore, slowly; and when it makes its exit from the first element, it is simply dry steam and not superheated steam.

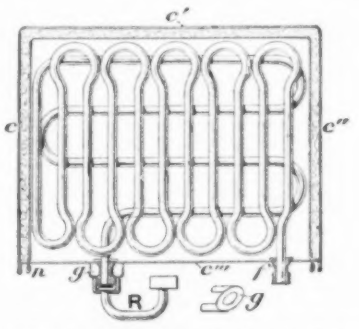


Fig. 6.—DIAGRAM SHOWING METHOD OF CONNECTING THE COILS OUTSIDE OF THE GENERATOR.

Beginning over again and making the water first enter the top coil, let us see what would occur. The top elements have relatively but little heat, and so, as the water descends, it is heated gradually, but is not quickly converted into steam. It will not vaporize probably till it reaches the 12th or 3th coil. In a word, it will, when it makes its exit from the 18th coil, be dry steam only, as before, after having consumed three or four times as much time as is allowable if it is to supply the needs of the motor, when the latter is working to its utmost.

M. Serpollet has made a very close study of the circulation of the water in his generator, and, finding that the most efficient plan of circulation is as follows, has arranged it thus:

The water, forced in by the hand pump or the automatic pump, enters the uppermost coil, 1, of the generator through the pipe, *O*, which is provided with a check valve at its lower end, in order that the entering water cannot be forced back. After being slightly heated in the top coil, the water descends through pipe, *P*, into the bottom coil, 18, which is the hottest one of the generator and which, accordingly, vaporizes the water at once. The steam then ascends through the next five elements (18, 17, 16, 15, and 14), after which it is transferred through pipe, *Q*, to the element, 2, which it passes through and then descends through the 11 coils below it, finally making its exit through pipe, *W*, at the end of coil 13. In its descent through these 11 coils, it gets nearer and nearer the fire, and consequently hotter and hotter, until, when it makes its exit through the asbestos-jacketed pipe, *W*, it is in a highly

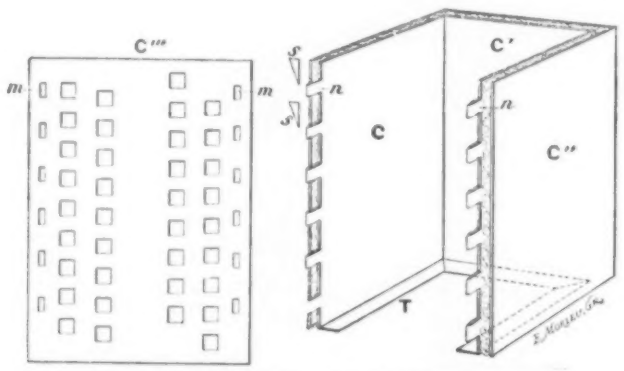


Fig. 3.—DIAGRAM SHOWING CONSTRUCTION OF GENERATOR CASING.

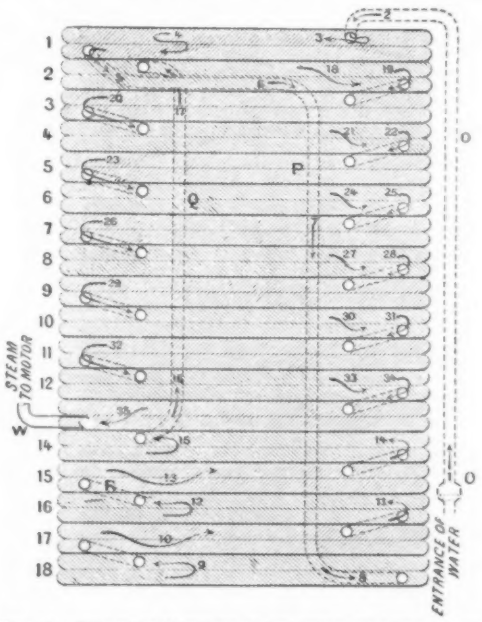


Fig. 7.—DIAGRAM SHOWING CIRCULATION OF WATER THROUGH THE COILS OF THE GENERATOR.

* Specially prepared for the Scientific American Supplement from a description by M. A. Baudry de Saunier in La Locomotion.

superheated state. The direction of the circulation through the tubes of the generator is indicated by the arrows in Fig. 7, and can be readily traced.

In general, therefore, we have seen that every Serpollet generator is divided into three parts: a feed-water heater, consisting of but one coil—the top one; the vaporizer, always formed by the five bottom coils; and a superheater, formed by the coils between the uppermost and the five lower ones. These coils vary in number according to the size of the motor.

The steam circulates in the generator with great rapidity. For example, the motor of the 12-horsepower car has a 75-millimeter (2.952 inch) bore by 90-millimeter (3.543-inch) stroke. Each of the 4 cylinders, therefore, has a volume of 400 cubic centimeters or a total of 1.6 liters. Since the motor never works with full admission, but steam is let into the cylinders on an average only during half the stroke, the total volume of steam furnished is only 800 cubic centimeters. As the number of revs per minute may reach 800, the cylinders can therefore consume 640 liters of steam in a minute. And as the mean internal diameter of the tubing of the elements is only 12 millimeters, which is equivalent to a surface of 1.131 centimeter, by dividing 640 cubic centimeters by 1.131, we obtain 5,660 meters as the distance covered per minute by the steam in its passage through the generator. Thus we see that in order to keep up with the demands of the motor, the generator must supply steam to the engine at the amazingly rapid rate of speed of 339 kilometers (203.4 miles) an hour!

Such a scouring do the tubes get by the steam, that when they are cut open for examination in the laboratory, they are found to be bright and shining; and, after three or four years' use, they will be found to have diminished in thickness in the bands. Thus it will be readily seen how impossible it is for carbon deposits to form within the tubes and choke them up, as it has sometimes been thought would happen.

THE NERNST INCANDESCENT LAMP.

THE Nernst incandescent lamp, several types of which, devised for laboratory study, have already been described, has finally made its appearance in commerce. In order to give a clear idea of this lamp we shall successively examine its structure, the present types of it, the results obtained with it, and its advantages and disadvantages.

The Nernst lamp, as is well known, is based upon the use of an electrolytic conductor as a luminous filament, that is to say, of a conductor of which the electric resistance diminishes when the temperature increases. The filaments are formed of oxides of zirconium, thorium, and other rare earth-metals, which become conductors only at a temperature of 600 deg. C. The lamp, therefore, comprises, in the first place, an arrangement that permits of heating the filament to redness before passing a current through it and utilizing it as a luminous body. For this purpose, a heating coil of wire surrounds the filament. This coil is traversed first by the current, and, after the filament has become incandescent, an interrupter operates automatically and cuts the current off from the heating apparatus.

Experiment has shown that when the intensity of the current increases in the filament, the difference of potential at the terminals of the filament increases in the first place, remains constant for a short time, and afterward continues to diminish. The best conditions of operation are those in which the difference of potential is constant. Increases of potential would have the great drawback of increasing the intensity of the current in the filament, and consequently of deteriorating it. In order to prevent this, a special resistance which offers an obstacle to variations in potential is mounted in series with the filament. This resistance is formed of a very fine iron wire placed in a bulb of hydrogen. Iron is the one metal whose resistance increases most with the temperature. The result is that it is easily capable of compensating for the inverse variation of the electric conductivity of the Nernst filament. These are conditions that we shall see realized in all the Nernst lamps, and that permit of the practical operation of them.

The lamps now on the market in France, and which are manufactured at the establishments of the Société à Saint-Ouen les Docks, are of two types—a large one, *A*, for luminous intensities of from 62 to 176 candle power, at voltages of from 96 to 250, and current consumption of 0.5 and 1 ampere; and a small type, *B*, for luminous intensities of from 13.5 to 48 candle power, at voltages of from 96 to 250, and current consumption of 0.25 and 0.5 ampere. Another lamp has been manufactured that has a consumption of 0.32 ampere, but that is only suitable for voltages of from 90 to 165. No. 1 of the accompanying illustrations represents, at one-third actual size, a lamp of the large type, *A*, and No. 2 one of the small type, *B*.

The lamp of the *A* type is formed of a vertical filament placed in the center of a porcelain spiral, with a platinum wire wound around the coils. The whole is suspended from a disc of porcelain, upon the sides of which are two binding posts, and in the center a flat piece with a binding screw. The burner is thus fixed upon the lamp and kept immovable. Upon the plate, *B*, are placed, on the left, a rod for the entrance of the current, and, on the right, a second one for the exit of the current, and a small electro-magnet which is utilized for the interruption of the heating current. The current, entering through one rod, passes through the flat spring forming the armature of the electro-magnet, traverses the heating spiral, and makes its exit through the second rod. The heating spiral becomes red-hot, and, after about 30 seconds, the Nernst filament reaches a temperature of 600 deg. C. (1,080 deg. F.), and becomes a conductor. A shunt current is then established, passing through a circuit formed of the filament of resistance, *C*, and of the coil of the electro-magnet. As soon as this current has reached a certain intensity, the electro-magnet attracts its armature and the circuit that supplied the heating spiral is broken.

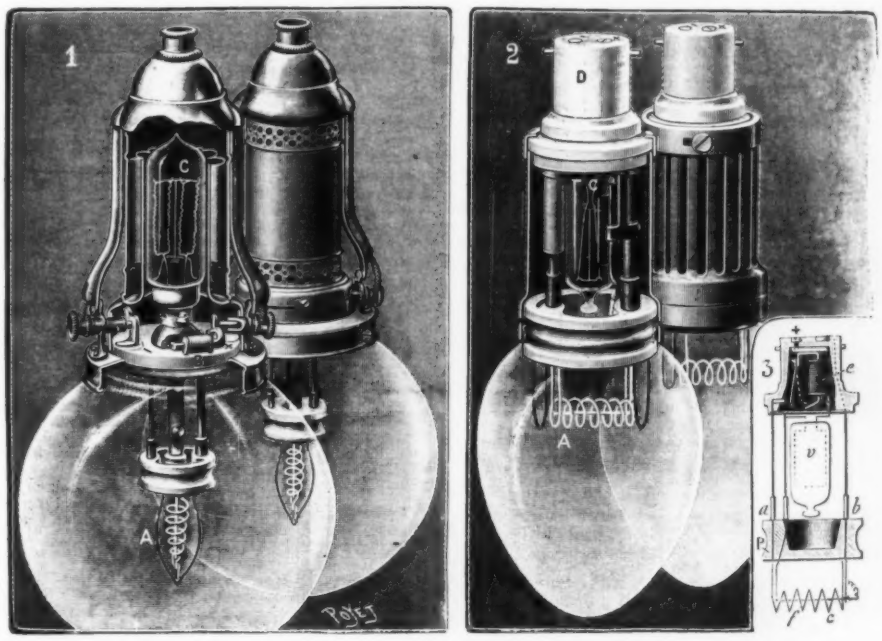
The same arrangements have been adopted for the lamps of the *B* type. In these, however, the filament, *A*, is horizontal, the resistance, *C*, is housed in a cavity above, and *D* is the chamber in which is placed the electro-magnet, as shown in the diagram. The current enters at the positive terminal, passes into the armature of the electro-magnet, reaches *a*, traverses the heating spiral, *c*, and returns through the rod, *b*, to the negative terminal. When the filament, *f*, becomes a conductor, a shunt is established, and the current passes through the coil of the electro-magnet *e*, the resistance, *v*, and the filament, *f*. The armature of the electro-magnet is attracted, and the circuit through conductor, *a*, and heating coil, *c*, is broken. The displacement of the armature is indicated by dotted lines in the figure.

Some precise experiments have already been made with the Nernst lamps. In May, 1902, the Physikalisch-Technische Reinsanstalt made some experiments with five 220-volt lamps with straight filaments, and five with curved filaments. Out of the five with straight filaments, one broke after 310 hours, a second after 379 hours, while the three others were intact after 400. The average life is therefore 379 hours. The heating spirals remained in good order. Of the five lamps with curved filaments, one of the filaments burned out after 150 hours, while the four others were intact after 400. Two testing spirals were broken after periods of 110 and 395 hours, respectively. The conclusion derived from these experiments was that a Nernst lamp of from 30 to 35 candle power at 220 volts is capable of lasting 300 hours with a gradual reduction of light of 20 per cent, and an average specific consumption of 2 watts per decimal candle power. Ordinary incandescent lamps, as is well known, show a consumption of from 3 to 4 watts per candle power.

Mons. E. Hospitalier has experimentally determined the variations of the current during the period of lighting by utilizing the ondograph under special conditions, of which he has given an account in Industrie Electrique. He ascertained that at the moment at which the circuit is closed, the current traverses the heating spiral, which is cold, and takes on a certain intensity which regularly and rapidly diminishes in consequence of the heating of the spiral and of its increase in resistance. After about ten seconds the rate of flow is established and the current keeps constant while heating the incandescent filament. After about forty seconds, the filament, sufficiently heated, begins to become a conductor, and a slight current traverses it, in addition to that in the spiral. This current rapidly increases, and the curve traced by the ondograph, in the shape of a hook, shows the rapid increase very clearly, as well as an apparent decrease due to the fact that after the intensity has reached a sufficient value, the electro-magnet operates and cuts the heating spiral out of circuit. There no longer remains anything upon the diagram, after the hook, except the straight line of the current traversing the filament. This current exceeds its regular rate of flow for an instant, until the auxiliary resistance has reached its normal value. In a large number of experiments the results were always the same; and nothing more was observed than differences of a few seconds only in the duration of the heating of the filament. In these experiments the heating current was, in its constant period, sensibly equal to half of the normal current. In a lamp consuming 1 ampere at 110 volts, or 110 watts, 15 volts are absorbed in the auxiliary resistance.

Some experiments were likewise made not long ago at the laboratory of the University of Birmingham, the results of which are recorded in Eclairage Electrique and the Journal of the Institute of Electrical Engineers. These experiments, comprising measurements of duration, luminous power, and consumption, were made with lamps of the 1902 type, using 100 watts at 110 volts. In all the experiments, there was observed during the first half hour a fall of 25 per cent in intensity in lamps that were forced, and of 10 per cent in those of normal voltage; then the fall became less marked and depended upon conditions of operation. At the normal potential, after 400 hours, there was a new and very pronounced fall, then a slight rise up to extinction. The average duration in three lamps was 473 hours. Destruction in three cases was due to the breakage of the platinum contact at the positive extremity of the rod. In conclusion, the author of the article indicates a luminous intensity of 0.48 candle power per watt expended. With the best incandescent lamps, as is well known, we obtain but 0.28 candle power. The expense of renewal in the Nernst lamps is, on the contrary, tripled. But, as an offset, they furnish 1,000 candle power hours at a cost of 22 cents, with current at 8 cents per kilowatt-hour, while it is necessary to reckon $1.10 with incandescent lamps, including the renewal of the latter.

The price of the Nernst lamps is quite high, say $4 and $5 for the large-sized lamp, *A*, complete, with resistance, burner, globe, and suspension ring. The price of the small lamp of type *B*, complete with bayonet catches or screws, is $1 with resistance, burner, and globe. The manipulation of the lamp requires great precaution, since the heating spiral is fragile. There are lamps for a continuous and for an alternating current. If burners for a continuous current are used upon an alternating one, and inversely, the filament may become quickly ruined. So too, a change in the direction of the current during the operation has a prejudicial influence upon the duration of the lamp. Before putting the lamps in use, it is well to observe the indications of current-direction marked upon the bottom of the globe. During the operation it is of importance that the difference of potential be not too high. Any increase therein has the effect of destroying the auxiliary resistance. If the lamp does not operate, it will be well to replace the resistance in the burner by another.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.



NERNST INCANDESCENT LAMPS.

1. Large type lamp (⅓ actual size). 2. Small type lamp (⅔ actual size). 3. Diagrammatic section of the small lamp.

LIME CULTURE IN THE WEST INDIES.

THE cultivation of limes in the West Indies is a rapidly developing industry, although it is at present somewhat small when compared with the sugar and cacao trades. The yield of the fruit per acre varies with the nature and quality of the soil, but on good ground 200 barrels of limes are yielded, diminishing to as low as 50 barrels per acre upon poor soil. The average yield, however, is about 120 barrels. From one barrel of limes, seven to eight gallons of juice are extracted. The latter is exported either raw or in a density of one gallon of concentrated to 12 gallons of raw juice. About 80 barrels of limes are required to yield 54 gallons of concentrated juice. One of the most important branches of the industry is the production of "essential oil of limes." This product is obtained from the rind of the fruit by the *ecuelle* process, before passing through the mills. The distilled oil, which is one of the forms in which this product is shipped, is recovered from the juice after milling by the usual distillation process. Only about 3 ounces of the rind oil is obtained per barrel of limes, while the yield of distilled oil is approximately 2½ gallons out of 54 gallons of concentrated juice.

THE ROMAN FOOT IN MEASURING.

THE Greeks and Romans adopted the human foot as the basis of their system of measures of length. There are five ways of determining the length of the Roman foot, viz., by ancient measures still in existence, by measuring known distances along roads, by measuring buildings, by derivation from measures of capacity, by measuring a degree on the earth's surface. The measurement of buildings is rather a verification of the value of the foot as obtained from other sources than an independent evidence. It very seldom happens that we know the number of ancient feet contained in the building measured. We have one such example in the Parthenon which was called "hecatompedon" (hundred-footed), from the width of its front, but even in this case we cannot tell exactly, till we know something of the length of the Greek foot, to what precise part of the front this measurement applies. Again, there is the obelisk in the Piazza del Popolo at Rome, and the Flaminian obelisk, the heights of which are given by Pliny. But the actual heights of these obelisks, as compared with Pliny, would give a value for the foot altogether different from that obtained from other sources. Indeed, the numbers in Pliny are undoubtedly corrupt. An ingenious emendation by Stuart would

remove the difficulty, but it is obvious that a passage which requires a conjectural emendation cannot be taken as an independent authority. There is another mode of deducing the value of the foot from buildings, of the dimensions of which we have no information. The building is measured, and the length thus obtained is divided by the supposed value of the ancient foot (as derived from other evidence), and if a remainder be left this value of the foot is corrected so that there may be no remainder. It is assumed in this process that no fractions of feet were allowed in the dimensions of the building, and also that the plans were worked out with the most minute exactness, both of which assumptions are not very probable. In fact, these measurements have given different values for the foot. "Modern architects," says Mr. Hussey, "do not allow that such calculations could be depended on in modern buildings for determining the true length of the measures by which they were planned. Nor are the dimensions of the parts of buildings of the Middle Ages in our own country, as gothic churches and cathedrals, found to agree exactly so as to give whole numbers of the standard measure." On the other hand, these measurements, like those on roads, have the advantage of involving in all probability very small errors, and of the diminution of the error by division. The average values of the Roman foot obtained from these various sources, in terms of the English foot, are the following: From ancient measures, .9718; from itinerary measurements, .97082; from measurements of buildings, .96994; from the congius (a liquid measure), .9832; from the length of a degree, .9724; of which the first three are the most to be depended on, and of those three the average is .9708, or 11.6496 inches, or 11½ inches, which we may take as the probable value of the Roman foot. Cagnazzi, whose researches are said by Niebuhr to have placed the true value of the Roman foot beyond a doubt, gives it a greater length than the above, namely, .29624 of a meter = .9722 of a foot, but this calculation is objected to by Böckh as being derived by a process not perfectly true from the value of the pound, and as being confirmed only by one existing measure, and also as being at variance with the value of the Greek foot obtained from independent sources. Böckh's own calculation, which agrees with that of Wurm, gives a value very little less than the above, namely, 131.15 Paris lines = .9704649 of the English foot = 11.6456 inches.—The Architect and Contract Reporter.

PROPORTIONS IN ARCHITECTURE.

MANY things dictated by instinct alone may produce beauties in architecture and yet not have proportions in the sense which ought to be attached to the word. Ask the Gothic architect if his pillars bear a fixed relation to their different parts. The answer will be that the pillar may have three, six, or even more times the height of its thickness, and that nothing of the sort is fixed in a determinate manner in any Gothic buildings, not even in a solitary edifice whatever may be its dimensions. Ask if the Gothic capital corresponds in size, form, and ornament with its pillar; facts themselves will tell you that caprice or chance alone decides its shape. Inquire if the different members and details agree with such and such a part of the arrangement, and you will be informed that no trouble has ever been taken about relative affinities which do not belong to the executive department. You will be shown the clumsiest supports by the side of the slenderest shafts; groups of little columns supporting nothing, and masses quite out of the perpendicular without any support at all. If you wish for an account of the exteriors of the churches, none can be rendered of confused parts and incoherent details carved out by the most ignorant caprice. The elevations of this style are never proportioned to their groundwork, and great boasting is made of their height, which only aspires to appear as an effort of mechanical skill. Gothic architecture has, therefore, no system of proportions, and it contains no principle of order which will enable us to discover from each part, detail, and ornament the reason which unites it to the whole and to the other parts, details, and ornaments of which that whole is composed. It must be remembered that Grecian architecture as exhibited in its remains, with those developments and modifications which have rendered it applicable to all nations, had not for its origin only that instinct which everywhere teaches the hewing and collecting of stones. It also possessed a kind of model consisting in itself of a combination of parts arranged and connected by reason and necessity. It therefore sprang from a pre-existing combination, of which it adopted the leading features, and hence arose its principle of order. In Greece the first edifices were formed of wood, which produced a combination of parts governed by a natural and uniform connection. This principle transferred to stone constructions a regularity of disposition which has been always subsequently followed too exactly to admit of anything merely dictated by necessity. The only model was the spirit of order and proportion, and this adhered to, the natural love of variety which exists in every human breast was sufficient to bring all the resources of the art in play to vary the expression; but, while following a system of proportions dictated by observing the construction of the wooden hut, architects found it necessary in order to arrive at perfection in their art to study the spirit that dictated the proportions observed in this construction from a still grander model—that of nature. This in Greece produced a result which did not occur elsewhere, and, in proportion to the progress made by Grecian artists in imitating nature in their images of the human body, did this spirit of imitation display its influence in architecture. In thus reflecting upon the common bond of union which exists between all the arts, we perceive at once how and why an ignorance of the proportions of the human frame must have had its reaction upon the Egyptian, Gothic, Indian, and other styles of building; also the reason why the architecture most distinguished for order and fixed proportions was that of a people who in painting, drawing, and sculpture had carried the study of scientific proportions to a higher pitch than any other nation.—The Architect and Contract Reporter.

ENGINEERING NOTES.

Some interesting tests made with alcohol as fuel for oil engines were recently carried out in New York. The object was to substitute alcohol for kerosene, the former being considerably cheaper and more readily obtainable in Cuba and South America, where many of these engines are being exported. It was found, says Power, that a mixture of four pints alcohol and two pints water developed four horse power for one hour. The mixture of alcohol varies, however, with the quality of the former, being limited by the practical degree of compression prior to combustion. The specific gravity of the mixture is .9; the pure alcohol was .794.

The economical handling of cupola stock and molten iron is one of the problems of large foundry management, and one which the Atlas Engine Works, Indianapolis, are attempting to solve by concentrating all melting operations at one point, from which the molten iron may be delivered to their three foundries. A melting house has been planned to hold six cupolas, and owing to the crowded nature of the ground-space, this house is located about a quarter of a mile away from the foundries. The furnace charges are made up in self-dumping cars, which, after passing over the yard scales will, by gravity, descend a track leading to an inclined plane, where an electric hoist and endless chain belt will furnish an automatic elevating apparatus for placing the cars on the cupola stage. After discharging its contents into one of the cupolas, the car passes on to the end of the melting house, and is returned to the stock-yard for refilling. The molten metal is conveyed from the cupola spouts to the foundries in Whiting geared truck-ladles of 10 tons capacity, and it is expected that when all is in working order, a ladleful of iron will reach its destination in under five minutes.—The Foundry.

The usual ignition outfit consists of a primary battery and spark coil, but widely different results are obtained. Some engines run for a year on one charge of battery; others require that the battery be renewed in three months, or less time. Much depends on the internal resistance and number of cells. Many have an idea that the more cells they connect in one series the longer the battery will last, while in reality just the opposite is true. If the internal resistance of the battery is small and discharge takes place under similar conditions, ten cells will run down twice as quickly as five. Hence it would cost four times as much to keep up as a five-cell battery. Many engines permit the sparking points to be in contact for a considerable portion of a revolution before they produce the spark. If the battery tends to polarize rapidly the spark may be very weak, owing to the fact that the battery has given up its best current before it is called upon to produce the spark. Much depends upon the spark-coil used. For economical ignition a good spark-coil is imperative. It has been shown that the current flowing depends directly on the resistance of the spark-coil and external circuit—that is to say, if the resistance be doubled but half the current will flow, and hence the battery will last just twice as long. To renew the battery usually costs more than the price of two or three good spark coils, yet some engine builders persist in sending out good batteries and cheap coils. That the cheap, low-resistance coil will give a good spark one can rest assured; but the fact must not be overlooked that the spark is produced by the large quantity of current which flows, and not by the efficiency of the coil itself. On the other hand, with a high-resistance coil, it is possible to secure just as good a spark with half the amount of current. —G. W. Frost, Amer. Mfr. and Iron Wld.

When a boiler explodes by failure of the bottom plates, it indicates an overheating of the plates over the fire by reason of low water or scale. For the first cause, the remedy is the use of low-water alarms or automatic feed-water regulators. The low-water alarms either blow a whistle or open a blow-off valve to relieve the boiler of pressure when the water in the boiler becomes lower than normal, and the automatic feed regulators will feed the boiler when the water level falls. These devices are also arranged to indicate high water as well as low, and are a valuable check or reminder to the water tender. For the second cause, the remedy is periodically to clean the boilers and remove the scale, the frequency of this operation being dependent upon the quantity of incrusting salts contained in the feed water. Fusible safety plugs of tin and lead alloys are a supposed protection from the effects of low water; but in actual practice they are, in general, failures, for the reason that they are protected from the heat by the accumulation of soot and dirt on the side toward the fire, and, moreover, a higher temperature is required to melt them after continued exposure to heat. The omission of fusible plugs is not advocated, but they should be properly set in the boiler and frequently inspected and cleaned and occasionally renewed to insure proper action. Low water in boilers is often due to imperfect gages and neglect of use of gage cocks. Low water is also frequently due to defective blow-off cocks, or to negligence on the part of the firemen in not entirely closing the cocks after blowing off a boiler. As a protection against high pressure, boilers are provided with safety pop valves, which should be set to blow off when pressure rises five pounds above normal boiler pressure. Pop valves should have ample outlet area, and should be tried and inspected daily to prevent the valves sticking to the valve seats, and rendering them inoperative. In general, all boiler explosions which are not the result of overheating of the crown plates from low water or scale are caused by weak longitudinal riveted seams. Proper workmanship, which will add 15 to 20 per cent to the strength of the boiler at practically the same cost, can be secured when the boiler is purchased under proper specifications, and the shop work is under the inspection of the purchaser's engineer. When boilers of proper construction are installed, equipped with automatic safety fittings, and given the periodical inspection of a boiler insurance company and competent attendance, the danger from explosion is remote.—Mod. Machy.

TRADE NOTES AND RECIPES.

Fly Paper.—

1. Chloride of cobalt	4 drachms
Water, hot	16 ounces
Brown sugar	1 ounce

Dissolve the cobalt in water, and add the sugar. Saturate unsized brown paper in the solution and hang the paper up to dry.

2. Potassium bichromate	10 parts
Sugar	30 parts
Oil of pepper	2 parts
Alcohol	20 parts
Water	120 parts

Mix thoroughly, digest for several days and filter off the liquid. In this solution soak unsized absorbent paper, allow to dry, and again soak and allow to dry.—Pharm. Era.

Solder for Glass.—A compound of tin (95 parts) and zinc (5 parts) melts at only 200 deg. C., and can then be firmly united to glass. An alloy of 90 parts of tin and 10 parts of aluminium melts at 390 deg. C., adheres, like the preceding, to glass, and is equally brilliant. With either of these alloys glass may be soldered as easily as metal, in two ways. In one, heat the pieces of glass in a furnace and rub a stick of soldering alloy over their surfaces. The alloy will melt, and can be easily spread by means of a roll of paper or a slip of aluminium. Press the pieces firmly together, and keep so until cool. In the other method a common soldering iron, or a rod of aluminium, is heated over a coal fire, a gas jet, or a flame supplied by petroleum. The hot iron is passed over the alloy and then over the pieces to be soldered, without the use of a dissolvent. Care should be taken that neither the soldering irons nor the glass be brought to a temperature above melting point of the alloy, lest the latter should be oxidized, which would prevent it from adhering.—Pharm. Era.

Bird lime is a thick, soft, tough, and sticky mass of a greenish color, has an unpleasant smell and bitter taste, melts easily on heating, and hardens when exposed in thin layers to the air. It is difficult to dissolve in alcohol, but easily soluble in hot alcohol, oil of turpentine, fat oils, and also somewhat in vinegar. The Techno-Chemical Recipe Book states that the best quality is prepared from the inner green bark of the holly (*Ilex aquifolium*), which is boiled, then put in barrels, and submitted for fourteen days to slight fermentation until it becomes sticky. Another process of preparing it is to mix the boiled bark with juice of mistletoe berries and burying it in the ground until fermented. The bark is then pulverized, boiled, and washed. Artificial bird lime is prepared by boiling and then igniting linseed oil, or boiling printing varnish until it is very tough and sticky. It is also prepared by dissolving cabinetmakers' glue in water and adding a concentrated solution of chloride of zinc. The mixture is very sticky, does not dry on exposure to the air, and has the advantage that it can be easily washed off the feathers of the birds.

A writer in the Metal Worker gives the following as good recipes for soft solder: A good soft solder is composed of 50 parts bismuth, 25 parts tin, and 25 parts lead. This mixture melts at 200 deg. F. Another good solder is composed of 50 parts bismuth, 30 parts lead, and 20 parts tin. This will melt at 190 deg. F. The solder that is used in soldering Britannia metal and block tin pipes is composed of two parts tin and one part lead. This melts in the blow-pipe flame at many degrees lower temperature than either tin or Britannia metal, and it is nearly of the same color. Care must be taken in mixing these solders to keep them well stirred when pouring into molds. Care should also be taken that metal which melts at a higher temperature be melted first and then allowed to cool to the melting temperature of the next metal to be added, and so on. Articles to be soldered with these solders should be joined with a blow pipe to get the best results, but if a copper is used it must be drawn out to a long, thin point. For a flux use powdered rosin or sweet oil.

Etching on Glass.—Fancy work, ornamental figures, lettering, and monograms are most easily and neatly cut into glass by the sand-blast process. Lines and figures on tubes, jars, etc., may be deeply etched by smearing the surface of the glass with beeswax, drawing the lines with a steel point, and exposing the glass to the fumes of hydrofluoric acid. This acid is obtained by putting powdered fluorspar into a tray made of sheet lead and pouring sulphuric acid on it, after which the tray is slightly warmed. The proportions will, of course, vary with the purity of the materials used, fluorspar (except when in crystals) being generally mixed with a large quantity of other matter, but this point need not affect the success of the operation. Enough acid to make a thin paste with the powdered spar will be about right. Where a lead tray is not at hand, the powdered spar may be poured on the glass and the acid poured on it and left for some time. As a general rule, the marks are opaque, but sometimes they are transparent. In this case, cut them deeply and fill up with black varnish, if they are required to be very plain, as in the case of graduated vessels. Liquid hydrofluoric acid has been recommended for etching, but is not suitable, as it leaves the surface on which it acts transparent. The agent which corrodes the glass is a gas which does not remain in the mixture of spar and acid, but passes off in the vapor.

The following formula has been published under the title of "Etching Ink":

Ammonium fluoride	2 drachms
Barium sulphate	2 drachms

Reduce to a fine powder in a mortar, then transfer to a lead dish and make into a thin writing-cream with hydrofluoric acid (some make use of fuming sulphuric acid). Use a piece of lead to stir the mixture. The "ink" may be put up in bottles coated with paraffin, which can be done by heating the bottle, pouring in some melted paraffin, and letting it flow all around. The writing is done with a quill, and in about half a minute the ink is washed off.

Extreme caution must be observed in handling the

acid, since when brought in contact with the skin it produces dangerous sores very difficult to heal. The vapor is also dangerously poisonous when inhaled.—Pharmaceutical Era.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

French-American Trade Requirements.—American exporters very often judge the value of their goods and the needs of foreign purchasers by their own standard. This standard may be true, as far as the conditions of the United States are concerned, and partly or entirely false when applied to other countries. The American manufacturer should know the requirements of the people whose trade he seeks and should try to satisfy them.

The French have fixed habits, from which they do not easily change nor wish to change. Once satisfied with a certain manufactured product and thoroughly accustomed to it, they will not change except from inability to obtain it or for marked improvement in some new article, which must be clearly demonstrated. Everybody wants the best, but the improved article or new product must be brought to the attention of the prospective purchaser in a very definite fashion.

Formerly Americans came to France to purchase brandy, and even paid the manufacturer a commission for selling them the product of his still. This condition still obtains in certain quarters, but the general conditions are changed. French distillers have found it necessary to send out traveling agents to secure business for them. One of the results is that Americans will often purchase an inferior grade of brandy of a "marque" already tasted rather than a superior quality of goods which they have never seen.

Our manufacturers often expend their energies and their money in a way far from practical. For instance, I receive at this office hundreds of circulars during the year, printed in English, describing certain articles of export. I send them to the proper dealers, but they cannot read them. There are instances where I have spent days in translating descriptive pamphlets at the request of the persons here in whose hands I had placed them. It is impossible to translate all, as no provision is made for work of this kind at this office. Even were descriptive circulars published in French and sent out to dealers, it would at best but prepare the mind of the French merchant for a commercial traveler. The traveler, unfortunately, does not follow the circular, and the energy is, to a great extent, lost. In view of existing modern trade bureaus and associations, it would seem possible that one traveler could represent several firms dealing in very diverse merchandise. By this means the dealer here could have what is necessary to successful business—a practical demonstration of the utility of any particular product.

American exporters desirous of doing business in France must adapt themselves to the needs of the country. Their circulars should be printed and their correspondence carried on in French. The commercial traveler should speak that language. The fact that neither buyer nor seller understands the other well causes at least hesitation and delay in reaching business. The French think, and perhaps with more or less reason, that we are not always careful enough in our business methods, and, although sincere in recommending our goods, are very often not sufficiently acquainted with the qualities they possess. We send our wares to France, declaring that there are none better. This may be perfectly true from our point of view, but the natural richness of our country has rendered us more or less prodigal and we have not made the careful study of the economic value of certain products that has been made in France. Let us take two commodities, coal and lubricating oils, for instance. Several million tons of coal are imported annually, while the entire quantity of petroleum used is imported. The necessity of buying from another country, of paying transport and high duty, has forced a careful study in economical values, by means of theoretic computation, most delicate laboratory tests, and practical experiment. Most of the French railway companies have laboratory apparatus for tests, not used at all by, and perhaps in some instances not known to, the shippers of the commodities.

Concerning coal there has been a woeful confusion in the definition of the terms *tout venant* (run-of-mine), *menu* (fine), etc. There is an evident and appreciable distinction between the French and American conceptions of what each considers equivalent terms. The result was that on receiving United States coal it was considered inferior to English coal sold under the same categorical name, the reason being that American exporters did not endeavor to maintain the relative proportions of large and small, not taking the French definition of *tout venant* into consideration.

While this misunderstanding is partly due to difference in language, it is principally due to disregard of the commercial customs of France. We may be able to impose our conditions when we wish to buy, but this is more difficult to do when we are the sellers. The purchaser should be put to the least possible inconvenience if we want to keep his trade. Our exporters should, as far as necessary, adapt themselves to the business habits of the people to whom they wish to sell.

There has been a large correspondence passing through this office relative to American phosphates and superphosphates. Our dealers insist:

1. In some instances, in quoting prices f. o. b., when they should know that, as a rule, transport or freight rates on regular lines are only quoted at the ports where the goods are to be put on board, and that agents at the port of destination are generally ignorant of freight rates to this port. It is only exceptionally that agents can quote other than rates from their ports.

2. That payment be made on basis of weighing and analysis at port of sailing. This is very favorable to the seller, but it indicates a certain lack of business confidence in the purchaser, who has just as much right to protect himself by weighing and analyzing the cargo on arrival in France. The seller may impose conditions on the sale of a necessity when he has no competitor; otherwise he should strive to please his customer. To show how far American business caution may be due to lack of knowledge of the French language and of business customs, take this illustration: In a comparatively recent transaction American shippers demanded payment on the basis of weight and analysis taken when phosphate was put on board in Florida. The French buyer offered payment on the basis of weight and analysis taken at La Rochelle. The result was that there was no agreement and the deal was declared off. An English broker presents himself, offers to the French buyer on the latter's conditions at slightly higher figure, and is accepted. The English broker knows of the American offer, which he accepts and orders goods shipped to La Rochelle. He has business confidence in the American shipper. The Frenchman pays more for his goods, but buys less American and more Algerian; the United States exporter gets his terms, but does less business. The evident need here is a better understanding, resulting in direct transaction to the mutual interest of both countries, but especially to the one that sells.

Our exporters, in order to further their own interests, should also, as far as their relations with France are concerned, adapt their business to the metric system of weights and measures. There is nothing more annoying to a French purchaser than to be forced to make a reduction of our weights to the very reasonable and logical metric system. He may ask for a price per 100 kilogrammes (220.46 pounds), and his ton, to him, consists of 1,000 kilogrammes (2,204.6 pounds). Other nationalities who have maintained trade for any length of time with France quote prices by this system. We should do so if we wish to please. The French merchant will quote to us his fine brass wire twills by the square yard, knowing that thereby we grasp the matter at once. He will quote us prices of brandy per gallon for the same reason, although he buys by the hectoliter (26.417 gallons).

I believe that our commercial relations with France can be greatly augmented by a better mutual understanding of business habits and the requirements of the market. The friendliness of these relations would be still further enhanced by the total disappearance of that suspicion which owes its existence to lack of acquaintance.

No man has a keener sense of business honor than a Frenchman. Cultivation of his acquaintance by actual contact in business will dispel on both sides any doubts of the genuineness of American or French sincerity.—George H. Jackson, Consul at La Rochelle.

American Corn Meal and Hominy in France.—For years the United States tried to acquaint European countries with corn and its products, but as far as France is concerned made little headway.

The corn meal sold here is not as good as that sold in the United States. It is too coarse and hard. Our exporters send this kind for its better appearance, perhaps, but the result is a very fine hominy instead of meal. Besides, the yellow product is packed separately from the white, hence a loss of the better taste obtained by grinding together. Further, from a French standpoint it is not only inartistically packed, but, in some cases, imperfectly so. It is usually put up in 2-pound pasteboard boxes, through the mucilaged or glued ends of which the contents often filter. These boxes retail at 25 cents. To this price, if ordered from Paris—as is necessary in this city throughout this district—freight must be added. The reason for such an exorbitant price is not easy to see, since the tariff entrance on meal is only 96.5 cents per 100 kilogrammes (220.46 pounds), making the duty on a 2-pound box actually less than 9 mills. Another reason why corn meal has not found favor in France is that the efforts made for its introduction were made to get the middle and wealthier classes to like it instead of the working people. The directions, printed exclusively in English, explain the making of johnny cakes, griddle cakes, corn-meal mush, and gems; but corn bread, to which use 75 per cent of the consumption in the United States is put, to serve with the vegetable course, is not mentioned. The French desire economical food, but it must be nourishing, and they know the most nourishing is the cheapest. What better fulfills these conditions than corn and its products? But before it ranks in France with eggs, cheese, butter, wheat bread, and such food, upon which the people now principally live, it must be ground and packed differently and sold at least 50 per cent cheaper. If these conditions are fulfilled and the matter is pushed so that the working classes can become acquainted with the value of corn bread as a nutritive and economical accompaniment of all their vegetable dishes, there will be such a wholesale business done as to make the amount now sold but a dribble.

American grits, which are sold in few cities outside of Paris, are of a good quality, packed in 4½ and 5 pound sacks inartistically but securely tied. These retail for 1.75 francs (33.8 cents), an inexplicable contrast to that of corn meal. Perhaps one of the difficulties attending a large introduction of grits is that the French eat no early morning meal. Still there is no reason why they should not be taught to like a palatable dish at noon or evening.—Thornwell Haynes, Consul at Rouen.

Coal Trade at Gibraltar.—A Spanish paper published in Cadiz calls attention to the fact that there has been a decrease of 23 per cent in the coal trade at Gibraltar for the years 1901 and 1902.

In 1901 the shipments were 218,782 tons, as against 167,140 tons in 1902, a decrease of 51,642 tons. This decrease, the paper says, is not to be attributed to the coal strikes of April and May, which paralyzed the maritime activity of the British colonies. In fact, if the 51,642 tons sold in 1902 be added to the 35,500 tons which represents the loss caused by the strikes, there still remains 16,000 tons to be accounted for, which shows that there are other reasons for the decrease in trade noticeable since 1890.

The following statistics may be of interest: In 1889, vessels coaled at Gibraltar to the extent of 562,000 tons; in 1890, 450,000 tons; in 1901, 401,000 tons. In 1900 this figure fell to 303,000 tons; in 1901 to 219,000 tons; and in 1902 to 167,000 tons. From these figures it results that the port has lost during the period 1889-1902 nearly 400,000 tons—that is, 70 per cent.

The difficulties and special conditions which the port of Gibraltar offers to vessels coaling should be added.

The authorities do not permit operations except in the daytime and vessels must place themselves alongside of coal hulks, which often causes damage and reclamations. For these and other reasons few vessels call at Gibraltar. The city is losing daily in commercial importance. This can only be regained by the loss of the rock's essentially military and strategic character.—R. M. Bartleman, Consul at Cadiz.

Italy's Commercial and Industrial Situation.—One of Italy's leading commercial papers, Il Commercio, says that during the first three months of the year 1903 Italy's imports, including gold and silver, amounted to $92,200,600, against $84,322,286 for a like period in 1902. The exports were $72,761,000 for the first three months of 1903 and $68,901,000 for the same period of 1902. The increase in imports ($7,877,714) was due to increased importations in grains, flour, and raw products for pastries, etc. Cotton and cotton goods went up $1,698,400; next came animals and animal products, with an increase of $868,500. Following these came chemicals, apothecary wares, pitch, perfumeries, etc., to the amount of $675,500.

The exports increased by $3,860,000, made up for the most part of silk and silk goods. Besides its ever-increasing revenue from the thousands who visit her shores as travelers, Italy is earning increased sums by her rapidly reviving manufacturers. The waters of the Alps and Apennines are giving her as cheap power by means of electrical plants as coal is furnishing to Belgium, Germany, England, and the United States.

German Export Prices for Iron.—German papers report that an English firm has been awarded the contract for a large gasometer by the city of Copenhagen, being the lowest bidder—£10,930 ($53,185); the lowest German bid was £11,250 ($54,742). The curious part is that the English firm intends to use German material, finishing it in England. It will be bought in Germany at export prices, which are about cost or even less. The papers state that the German manufacturers of gas reservoirs can not purchase their raw material in Germany as cheaply as foreign firms can, and therefore cannot compete with English manufacturers. They also state that similar conditions exist in other branches of home industries using iron. The producers of iron are called upon to revise their prices in favor of home consumers.—Richard Guenther, Consul-General at Frankfort.

Rolling Stock of Russian Railways.—Consul-General Richard Guenther writes from Frankfort, June 24, 1903, as follows:

The St. Petersburg Gazette states that the number of passenger cars of all the public railways of Russia (Finland excepted) on January 1, 1903, was 15,345, valued at 98,461,858 rubles ($50,767,858), of which the government railways of European Russia owned 9,733; the private trunk lines, 3,858; the Asiatic government lines, 1,541; and the private local railways, 413. The total number of mail cars was 521 and of baggage cars 1,582, with a carrying capacity of 961,143 poods (17,311 tons). The total number of freight cars of the whole Russian system was 315,046, with a total carrying capacity of 232,586,669 poods (4,190,751 tons). The total value of these is estimated at 404,024,566 rubles ($208,072,655).

Trade Notes from Turkey.—The British vice-consul at Van states in a recent report, published in the Board of Trade Journal, London, that in the following classes of goods British products might compete favorably with those at present introduced, viz., cutlery, agricultural implements, carpenters' tools, waterproofs and goloshes, cheap bicycles, and all sorts of fancy goods. The dressed leather of Austro-Hungarian or German origin which is now on the market is stated to be of very inferior quality and the subject of constant complaints.

The British vice-consul at Diarbekir reports that printed calicoes from India are being largely replaced by printed cotton flannels of German manufacture.

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No. 1720. August 11.—Rubber-goods Industry of Germany—White Population of the British Colonies—Paraguayan-European Through Bills of Lading—Consular Notes: Gas and Electricity in Spain—Selium, an Alleged New Metal—Trade Opportunities Abroad: *Trade in the Wuchow, China, Consular District—*Methods Needed to Secure Foreign Trade—Resumé of Italy's Trade—*British Trade in China—Deepening the Harbor of Omuta, Japan—Development of the World's Steel Industry—Cultivation of Coutchouc in Kamerun—*India's Imports.

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No. 1722. August 13.—*Jute Crop of India for 1903—Distribution of Sewage on Bacteria Beds—Artificial Pumice—Sanitation of Congested Areas—*Failure of the Cocoon Crop of Piedmont—Canadian Customs Amendment Act—Purifying Water by Ozone—Consular Notes: Spanish Railways in 1902—Russian Commercial Expedition in Mongolia—Trade Opportunities Abroad; Germany's Foreign Trade—Chinese Chamber of Commerce.

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No. 1724. August 15.—Street Railways of Leipzig—*Insecurity of the Harbor of Valparaiso—Consular Notes: Population of the German Empire—*American vs. German Jewelry—*Tariff Classification Ribbons in Venezuela.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. The other Reports can be obtained by applying to the Bureau of Trade Relations, Department of Commerce and Labor, Washington, D. C. Since the number of Reports is limited, application for those which are desired should be made immediately.

SELECTED FORMULÆ.

Skin Varnish.—Used by surgeons to coat the fingers so as to minimize the transference of disease germs. The varnish is removed after completing the examination of the patient.

Copal	2 parts
Venice turpentine	4 parts
Ether	100 parts
Collodion	100 parts
Acetone	8 parts

—Spatula.

Waterproof Paste.—A formula for a paste which is intended to resist water, cold or hot, and which is also unaffected by alcohol or acids is published in the Druggists' Circular and Chemical Gazette:

I.

Chromic acid	2½ parts
Stronger ammonia	15 parts
Sulphuric acid	½ part
Cuprammonium solution	30 parts
Fine white paper	4 parts

II.

Isinglass, a sufficient quantity.

Acetic acid	1 part
Water	7 parts

Dissolve sufficient isinglass in the mixture of acetic acid and water to make a thin mucilage.

One of the solutions is applied to the surface of one sheet of paper and the other to the other sheet, and they are then pressed together.

Polish for Tan and Russia Shoes.—

I.

Soft, or green, soap	2 ounces
Linseed oil, raw	3 ounces
Annatto solution (in oil)	8 ounces
Yellow wax	3 ounces
Gum turpentine	8 ounces
Water	8 ounces

Dissolve the soap in the water and add the annatto; melt the wax in the oil and turpentine, and gradually stir in the soap solution, stirring until cold.

II.

Yellow wax	2 ounces
Fish oil, raw	2 ounces
Spirit of turpentine	15 ounces
Tincture of green soap	1 ounce
Yellow ocher	½ ounce

III.

Petrolatum	12 ounces
Yellow wax	4 ounces

IV.

Yellow wax	4 ounces
Pearl ash	½ ounce
Yellow soap	¼ ounce
Spirit of turpentine	8 ounces
Phosphine (anilin)	4 grains
Alcohol	½ ounce
Water, a sufficient quantity.	

Scrape the wax fine, and add it, together with the ash and soap, to 12 ounces of water. Boil all together until a smooth creamy mass is obtained; remove the heat and add the turpentine, and the anilin (previously dissolved in the alcohol). Mix thoroughly, and add sufficient water to bring the finished product up to 24 ounces.

V.

Yellow wax (dark)	1 ounce
Palm oil	1 ounce
Spirit of turpentine	3 ounces

Melt together on a water-bath and color if desired with Nankin brown (5 grains) dissolved in a little alcohol.—Drug. Circ. and Chem. Gaz.

Gum Drops.—The following formulæ for gum drops are published in the Druggists' Circular and Chemical Gazette from information furnished by the Confectioners' Journal:

I.

Grind 25 pounds of Arabian or Senegal gum, place it in a copper pan or in a steam-jacket kettle and pour 3 gallons of boiling water over it, stir it up well. Now set the pan with the gum into another pan containing boiling water and stir the gum slowly until dissolved, then strain it through a No. 40 sieve. Cook 19 pounds of sugar with sufficient water, 2 pounds of glucose and a teaspoonful of cream of tartar to a stiff ball, pour it over the gum, mix well, set the pan on the kettle with the hot water and let it steam for an hour and a half, taking care that the water in the kettle does not run dry; then open the door of the stove and cover the fire with ashes and let the gum settle for nearly an hour, then remove the scum which has settled on top, flavor and run out with the funnel dropper into the starch impressions and place the trays in the drying room for two days, or until dry; then take the drops out of the starch, clean them off well and place them in crystal pans, one or two layers. Cook sugar and water to 34½ degrees on the syrup gage and pour over the drops lukewarm. Let stand in a moderately warm place over night, then drain the syrup off and about an hour afterward knock the gum drops out on a clean table, pick them apart and place on trays until dry, when they are ready for sale.

II.

Place 10 pounds of ground gum in a copper pan, add 1½ gallons of boiling water, set on a pan containing hot water, and stir over the fire until the gum is melted; then strain through a fine sieve. Cook 35 pounds of sugar with sufficient water and a pinch of cream of tartar to 250 degrees of the thermometer, and add to the gum. Now place the pan on a fire covered with ashes and stir till the gum is boiling. It should run off the spatula like jelly, in a broad stream. Let stand in the hot water for about an hour, when the scum will rise to the surface, take it off carefully, flavor and run into starch impressions. Place in a hot drying room for two days; then take out carefully, blow off with a bellows and crystallize with a semi-cold crystal, cooked to 24 degrees of the syrup gage. The starch must be very dry or else the gum will take up the starch, which will make them white and crusty.

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